



ARCIA PROFESSIONAL DEVELOPMENT TRAINING PROGRAM

AUSTRALIAN RADIO COMMUNICATIONS INDUSTRY ASSOCIATION



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FUNDAMENTALS OF PRIVATE MOBILE NETWORKS (NPN)

HALF-DAY SESSION

About today.....

- Around 3-4 hours in duration – depends on the questions !
 - 9:00 – 12:30
 - Morning tea 10:30-11:00
- **Course aims:**
 - Focusing on Private mobile networks (NPN – Non Public Networks)
 - Help you start thinking about how to use private mobile networks in the industry.
 - Enable you to tell when salespeople and ‘industry experts’ are lying to you.
 - Appreciate the steps & considerations for deploying a network.
 - Encourage discussion.
- **The course is not highly technical**
 - Is designed for people in the radio/telecoms/communications industry however.
 - But we can go down any technical ‘rabbit hole’ you like !
 - Hopefully provides a ‘philosophical framework’.

Agenda

- Background intros
- What is LTE/4G ?
- What are private networks ?
 - 14 key 'concepts'
- Some specifics of these networks
- Public safety
- 5G – An Introduction
- How to build your own



Working Sub-title

“Response to some fundamental misunderstandings of 4G/5G we have recently heard uttered”



Background to Presenter & Participants

Background to Challenge Networks

- A systems integrator that specifically builds 'Carrier networks' - PSTN, data & mobile
- Has partnerships with the Tier 1 telecom vendors and several of the Tier 2.
- Focuses on smaller networks (less than 1-2 million subscribers).
- Has built 'turn-key' mobile networks in multiple countries around the world.
- The CN strategy is to develop 'best for customer' solutions rather than restricting to any single vendor product portfolio.
- Now has taken our expertise in carrier network design/build/support to include private/industrial 4G/5G networks.
- In April 2023 was purchased by Vocus, now the 'Wireless group' within them.



Vocus at a glance



Connecting 2/3 of the ASX 200 and more than 200 govt agencies



25,000km national fibre network



Networks and technology solutions provider



Providing international connectivity via Australia Singapore Cable



Leading provider to space and satellite industry



\$1b investment in network over the next five years



Owned by a consortium of Macquarie Asset Management and Aware Super



Why we might have a (bit) of a valid view.....

- First integrator in world to build a private 4G network.
- First to build private 4G network using Nokia RAN.
- First to deploy Private 4G network in Peru.
- Deployed first network into Gold mining and first into oil & gas.
- First in Australia to use Band1 (2100MHz) for 4G.
- First to deploy with CATM1 as integrated mine 4G/IoT solution.
- First to deploy 'greenfield' mine site with only MCPTT-LTE voice solution rather than legacy UHF/VHF.
- Now has 25 + private 4G network deployments (both above and below ground).
- Solutions deployed in Europe, South America & Australia.




A large white pipeline stretches across a desert landscape. The pipeline is supported by a metal structure and runs from the foreground towards the horizon. In the background, there are rolling mountains under a clear blue sky. The scene is illuminated by warm, golden light, suggesting sunrise or sunset.

Why care about 4G/5G ?

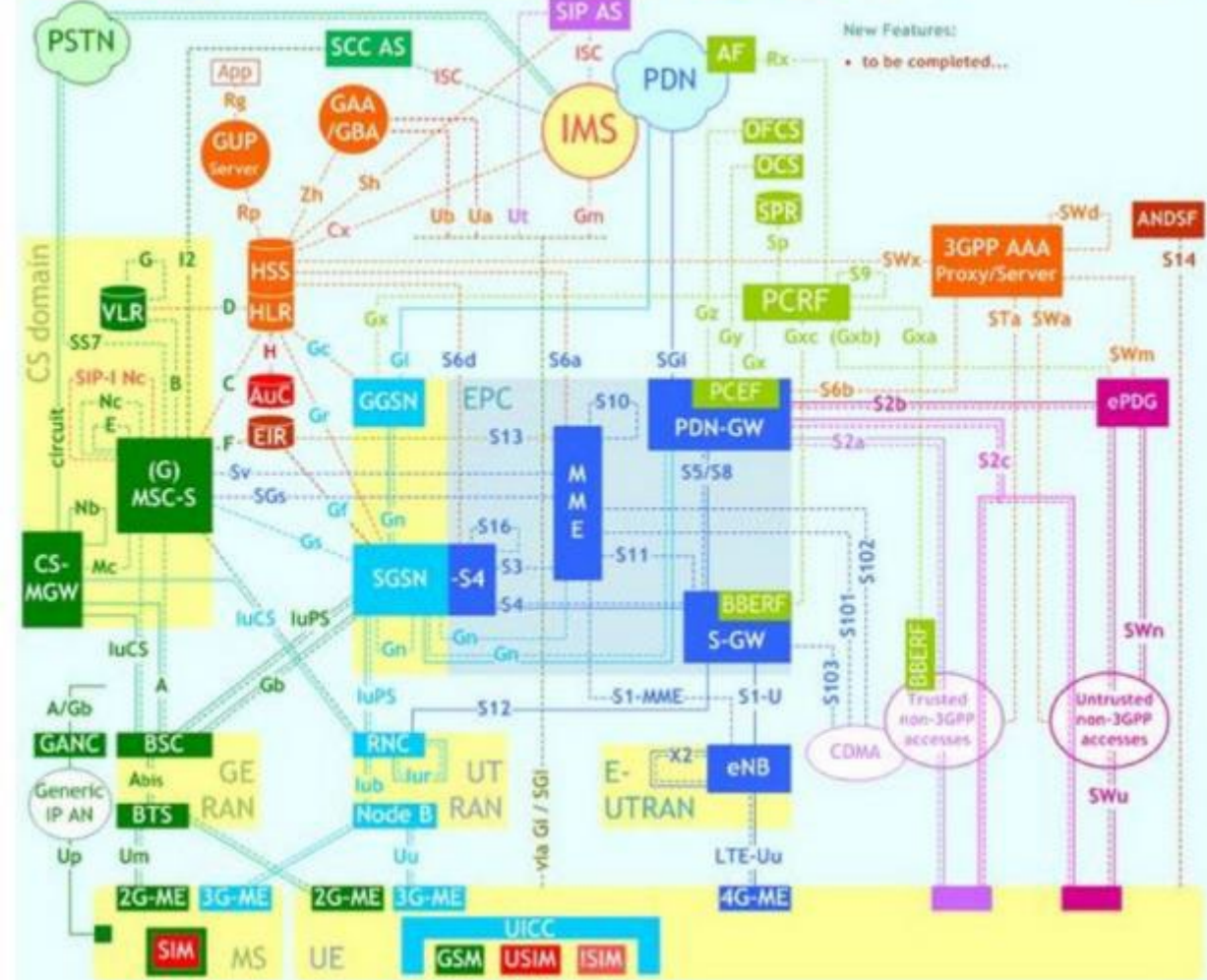
Why the interest ?

(Reasons why you came here today ?)

- Greater connectivity (both fixed and wireless) considered to be a key enabler for future technology
- Data needs & user numbers continue to rise. Connecting your fridge to the Internet....
- WiMAX is (very) dead
- Wi-Fi often seen to have reached it's technical limits
- P25/TETRA/DMR reaching capability & (maybe) EOL
- 4G & 5G becoming cheaper
- Uncertain future for some vendors/industry segments
- 4G/5G often seen as 'killing' other wireless technologies
- Pressure for efficiency & safety improvement

A large yellow mining truck is positioned in a dimly lit underground tunnel. The truck is facing right, and its massive tires and heavy-duty body are clearly visible. The tunnel walls are rough and rocky, and the floor is covered in dust and debris. A bright light source, likely a headlamp or work light, illuminates the scene from the right, casting long shadows and highlighting the texture of the rock.

So what is 4G/5G/LTE/NPN ?



The 'boxes'

- Tight definition over the 'box' interconnects
- Tight definition over the functions of each box
- Loose definition over how each box works



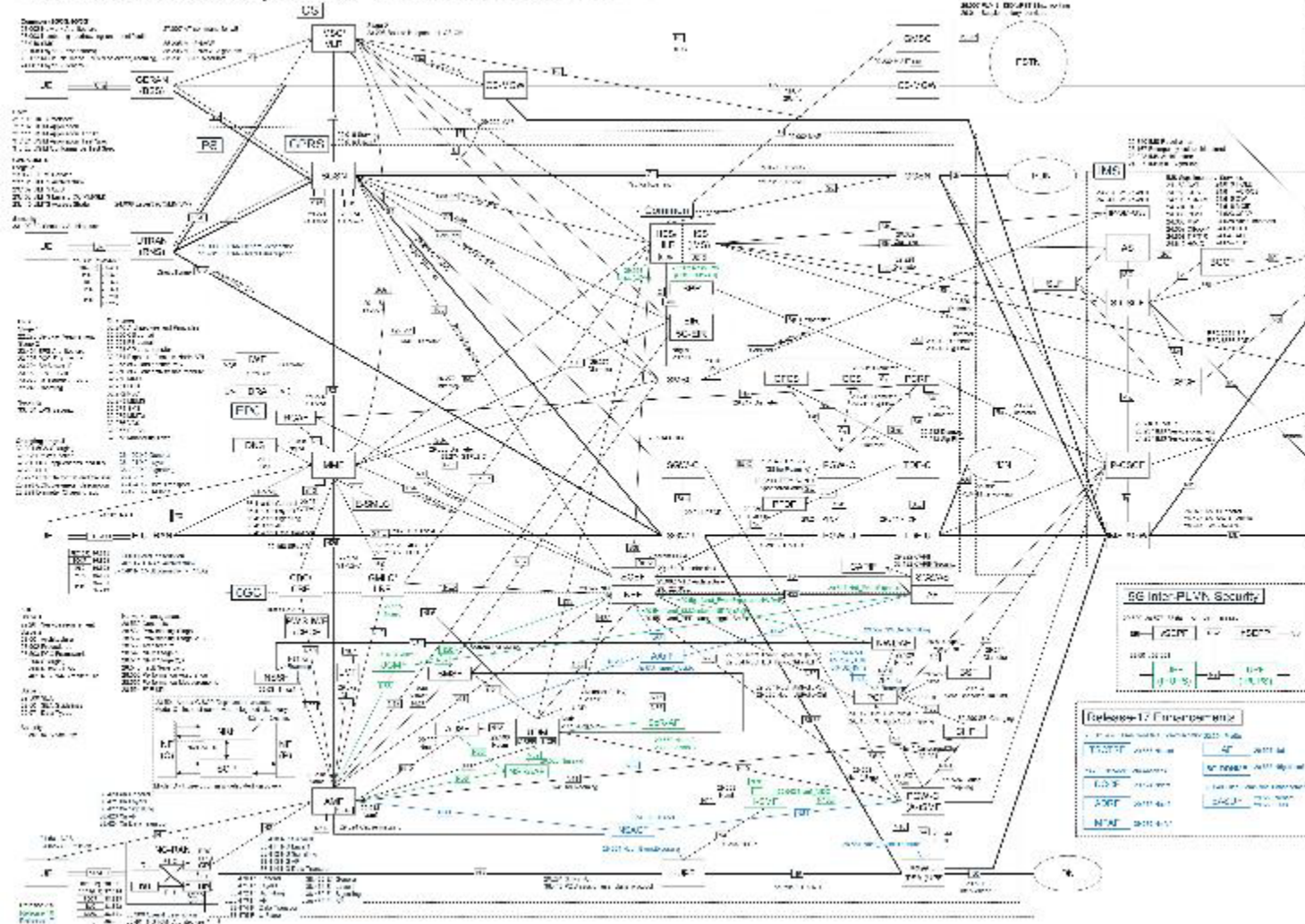
A GLOBAL INITIATIVE

Source:
in2EPS

VOCUS



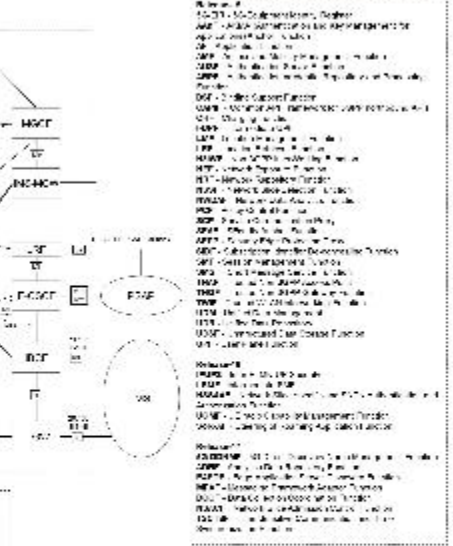
3GPP Overall Architecture and Specifications



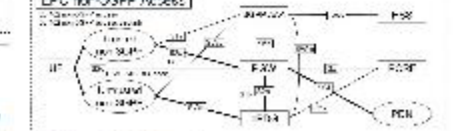
4G and 5G Core Network

4G Core Network	5G Core Network
MSC (Mobile Switching Center)	MME (Mobility Management Entity)
HSS (Home Subscriber System)	HSS (Home Subscriber System)
S-GW (Serving Gateway)	S-GW (Serving Gateway)
M-GW (PDN Gateway)	M-GW (PDN Gateway)
PCRF (Policy and Charging Rules Function)	PCRF (Policy and Charging Rules Function)
SMF (Session Management Function)	SMF (Session Management Function)
NFV (Network Function Virtualization)	NFV (Network Function Virtualization)
SD-WAN (Software Defined Wide Area Network)	SD-WAN (Software Defined Wide Area Network)
5G Core (5GC)	5G Core (5GC)
4G Core (4GC)	4G Core (4GC)
3G Core (3GC)	3G Core (3GC)

5G Network Function Architecture



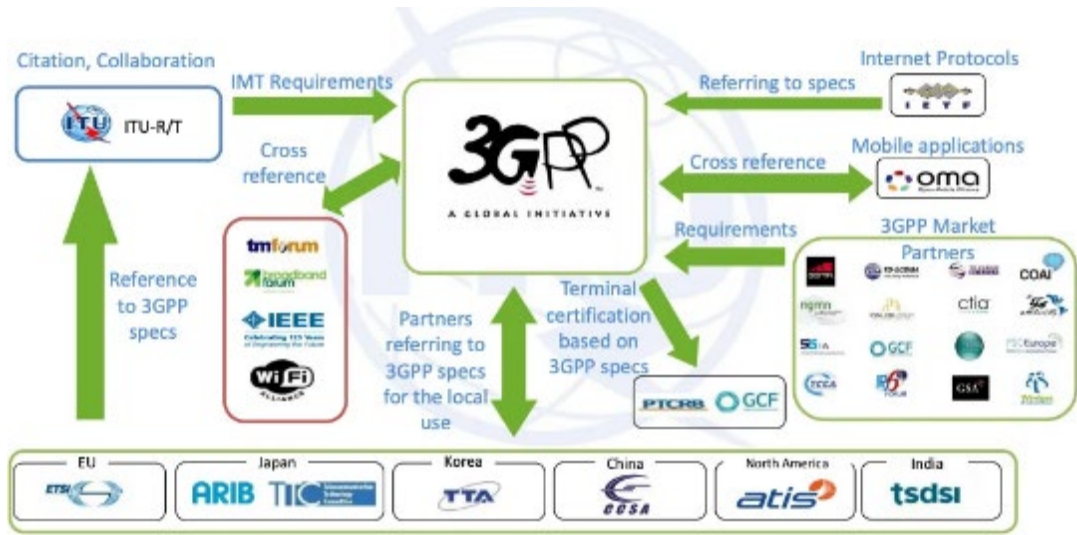
L4/L5 non-5G Access



5G Core Network



Concept #1, #2 & #3



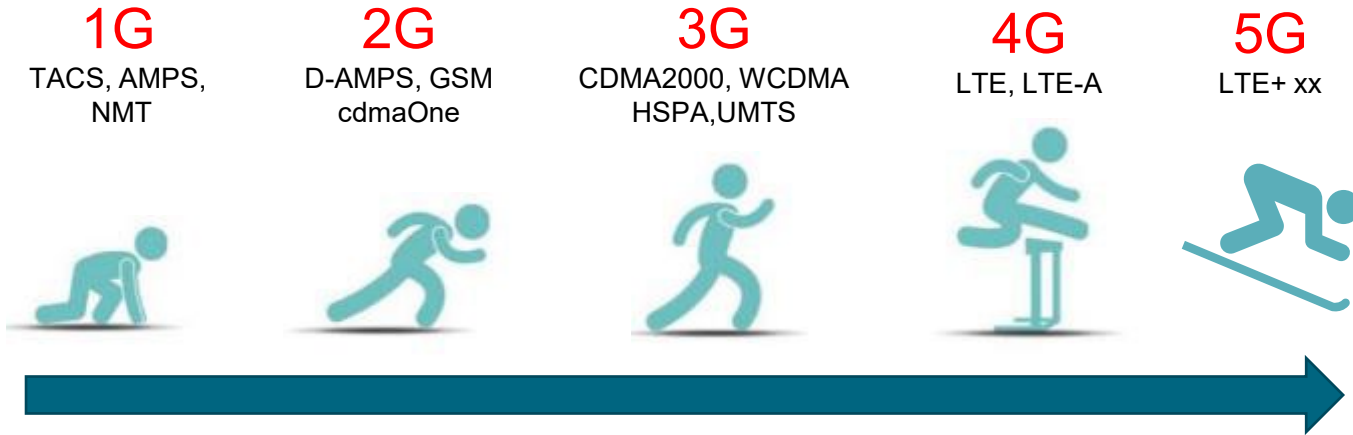
- 4G/5G is “unknowable”
- 4G/5G is a ‘standard’ – not a technology
 - Terms are confusing & misused all the time
 - Strictly speaking LTE is not 4G
- Multi-vendor solutions are to be encouraged
 - Or at least not suggested as being impossible.
 - ‘Open RAN’ is a new example of this

History of 4G/5G

“History is the sum total of things that could have been avoided.”
- Konrad Adenauer

Back to the beginning of the universe.....

Evolution of Mobile



Mobile 3GPP versions

Releases are made approximately every 6-18 months

TIME



- Release 8
 - Release 9
 - Release 10
 - Release 11
 - Release 12
 - Release 13
 - Release 14
 - Release 15
 - Release 16
 - Release 17
 - Release 18
 - Release 19
 - Release 20
 - Release 21
- } Release when 'LTE' was first defined and '3G' stopped
 - } Release when '4G' was first defined
 - } Was Frozen in Q1 2016
 - } This is where '5G' was being added
 - } Most deployments are at these levels
 - } Release 18 being 'Stage 2 Frozen' in March 2024.
 - } Currently being defined

Please note: This is a basic representation of the releases to demonstrate the general flow of development. A lot more detail should be added to make this absolutely correct

Concepts #4 & #5

- **3GPP is a journey not a destination**
 - Unlikely to be ever 'complete'.
 - Is an ecosystem.
 - It's generally backward compatible.
 - '5G' is really just yet another new 3GPP Release (marketing term not a technical one) {Will talk about 5G latter}
- **You don't have to test your solution against the 3GPP specifications !**
 - unless perhaps you buy a solution from some questionable Tier 2-3 vendor....
 - You want to employ lots of people.
 - Just test for unusual use cases & integration.



What is NPN (Non Public Network) ?

- **A 3GPP defined mobile network (aka LTE/4G/5G/6G)**
&
- **Used specifically for non-consumer (aka Industrial, M2M & IoT use).**
&
- **Separate (technically &/or logically) from a consumer mobile network (MNO)**
&
- **Not necessarily owned/managed by a MNO.**
&
- **Is the 3GPP ‘proper term’ for :**
 - **‘Private LTE network’**
 - **‘Private 4G/5G network’**
 - **‘pLTE’**

Why NPN?

It is generally accepted that for industrial enterprises private 4G (and 5G) networks are the logical migration path from legacy wireless (Wi-Fi, UHF, VHF, mesh) solutions

- **Supports demands of industry requirements:**
 - ✓ More data
 - ✓ More devices
 - ✓ More connectivity
- **Communication convergence:**
 - ✓ One infrastructure, many applications
- **Economic efficiency:**
 - ✓ Reduction in costs
- **Roadmap:**
 - ✓ Replaces TETRA/P25
 - ✓ Long term future
- **Value add:**
 - ✓ Typically - 3% to 10% increase to mine efficiency
- **Technology advantages:**
 - ✓ Distance
 - ✓ Speed
 - ✓ QoS



Who would use NPN ?

- Potentially whoever has a UHF/VHF radio and/or a large Wi-Fi/Mesh network today
 - Mining/Oil & Gas/Resources
 - Public safety
 - Utilities (water, gas, power, etc)
 - Manufacturing
 - Airports/Ports
 - Rail
 - Healthcare
 - Agriculture
 - Hotels/stadiums/arenas

Why not just use existing consumer network (MNO)?

There are significant differences....

Consumer Mobile networks	Mining/Industrial Networks
Consumer focus	Specific use focus & integration
General coverage focus	Specific & targeted location(s)
Large number of low value subscribers	Small number of high value subscribers
'Reasonable' reliability	'Mission critical' reliability
No Quality of Service	Full Quality of service to individual users
Low level of network security	High level of network security
Control by MNO	Control by Enterprise

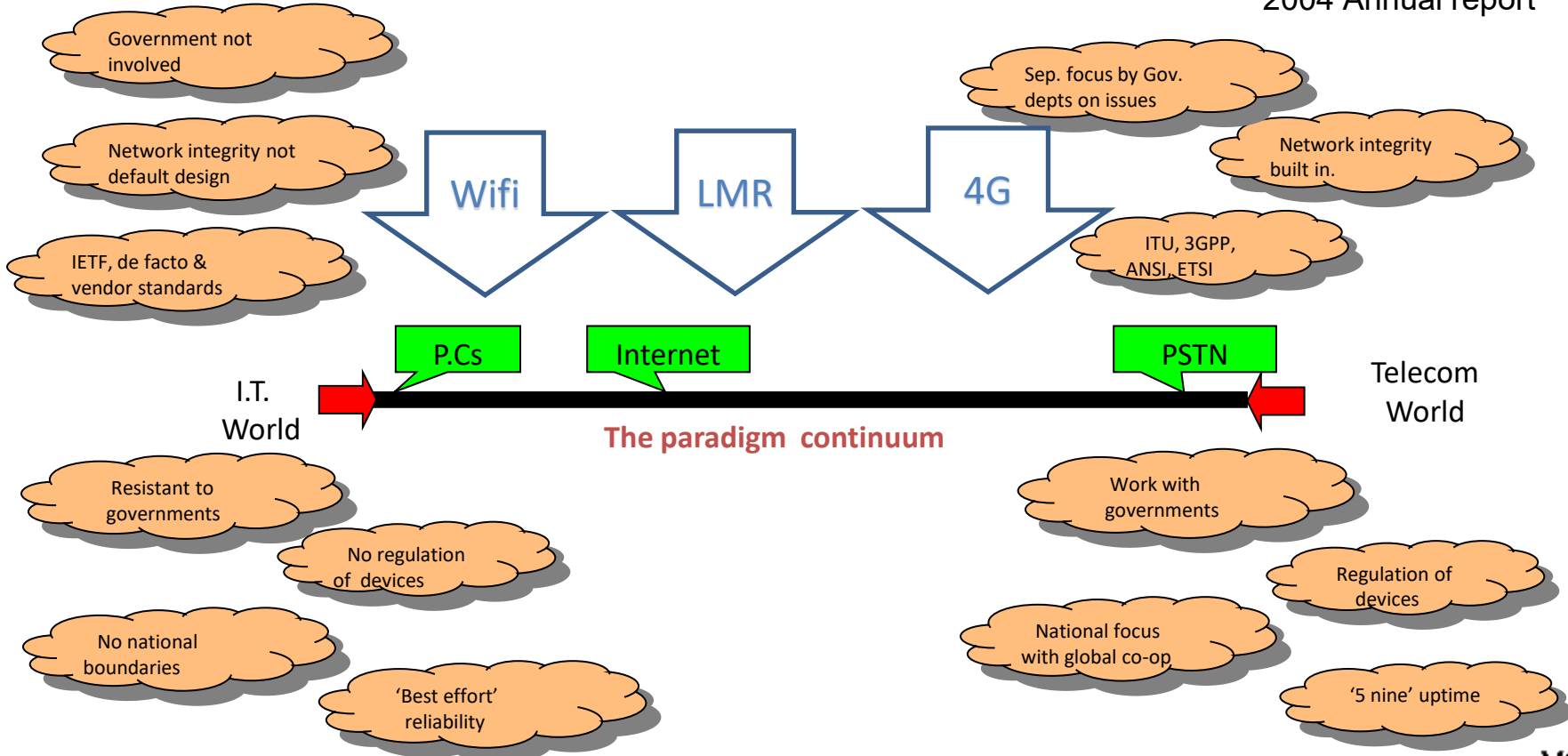


Concept #6

- **Private 4G ≠ Public/Consumer 4G**
 - Based on same technology but implemented completely differently
 - Performance characteristics completely different
 - Like comparing a Commodore to a Land Rover Discovery: Both based on the same base technology but very different implementations

'The clash of cultures' – Internet versus Telecom

Source: ACMA Vision 2020
2004 Annual report

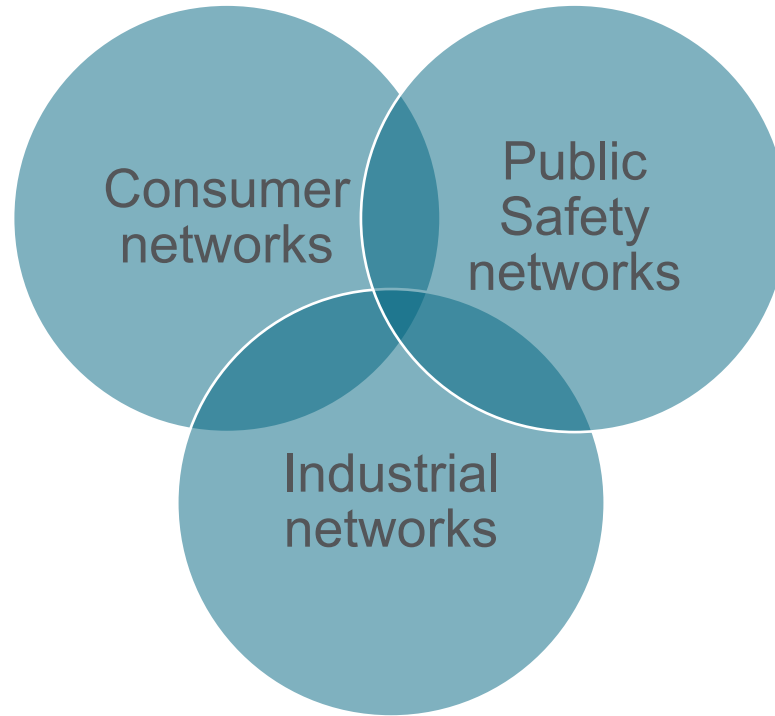


Concept #7

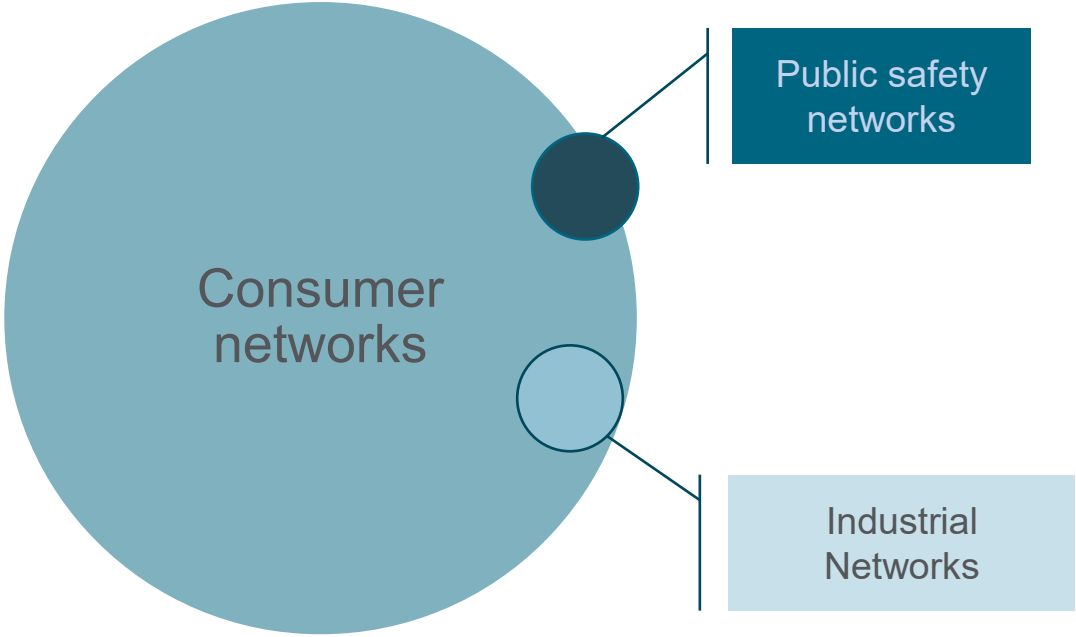
- This convergence of cultures is not to be underestimated
 - See it in 'IT team' vs 'OT team' clashes.
 - Different technology paths.
 - Potentially 'blood on floor' between teams during deployments.
 - Typically the number 1 reason why your 4G/5G network may fail in your business.



Three key market segments of 4G/5G - Logical



Three key market segments of 4G/5G – \$ Market Share



Concept #8

- **Don't confuse the market segments**
 - Some are more mature than others
 - They have very different challenges
 - The 4G/5G implementations of these segments are different to each other
 - A consumer network is very different to an industrial network which is very different to a public safety network.....



Concept #9

- “Those who have the gold make the rules”
 - Standards driven more by the large carriers & vendors
 - Why the needs of the ‘little guys’ (Industrial & public safety) delayed



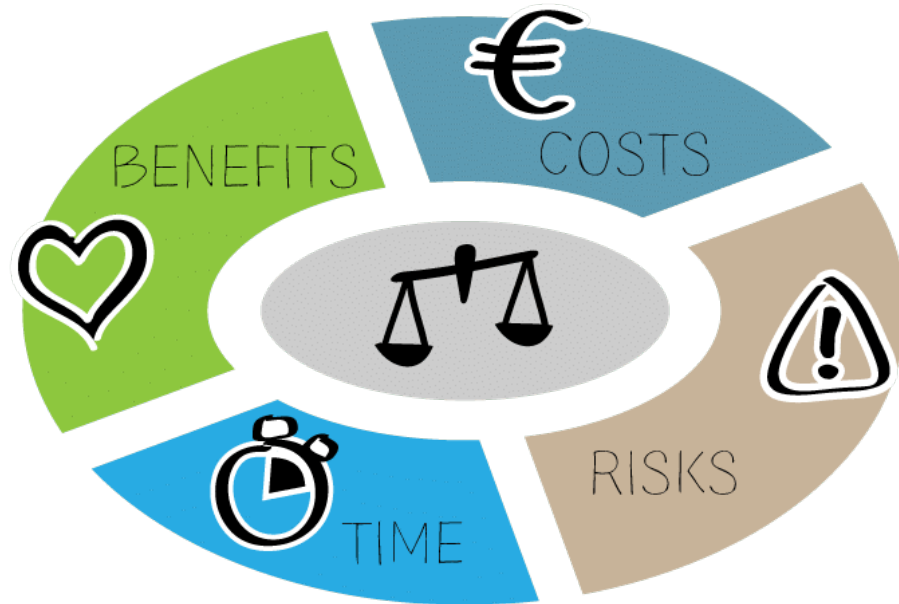
What are the Key 4G Connectivity Advantages:

- **4G Coverage Capability at Distance (1-30km)**
 - ✓ Lower number of sites than legacy technologies for same coverage.
 - ✓ Able to cost effectively provide broader coverage to whole mine site.
 - ✓ A open cut mine of 20km x 10km would nominally require 5-10 LTE macro sites for complete mine coverage (compared to 200+ sites with Wi-Fi)
- **RF Interface**
 - ✓ QOS. Able to run multiple services on different devices with guaranteed performance
 - ✓ Handover. Devices can move around the mine site with no performance impact to another.
 - ✓ Continuous device throughputs of 1-50 Mbps depending on device & application.
 - ✓ Multiple 'Networks' can be run on the one single infrastructure network.
- **Fully Scalable**
 - ✓ Network capacity and coverage can be expanded to mine user requirements.
- **User Devices**
 - ✓ A global ecosystem of modems, tablets, handsets, developed for a worldwide user base.
- **Lower Cost of Ownership (both CAPEX and OPEX)**
 - ✓ Greater economies of scale on expansion compared to alternative technologies.
 - ✓ Much lower maintenance costs than Wi-Fi

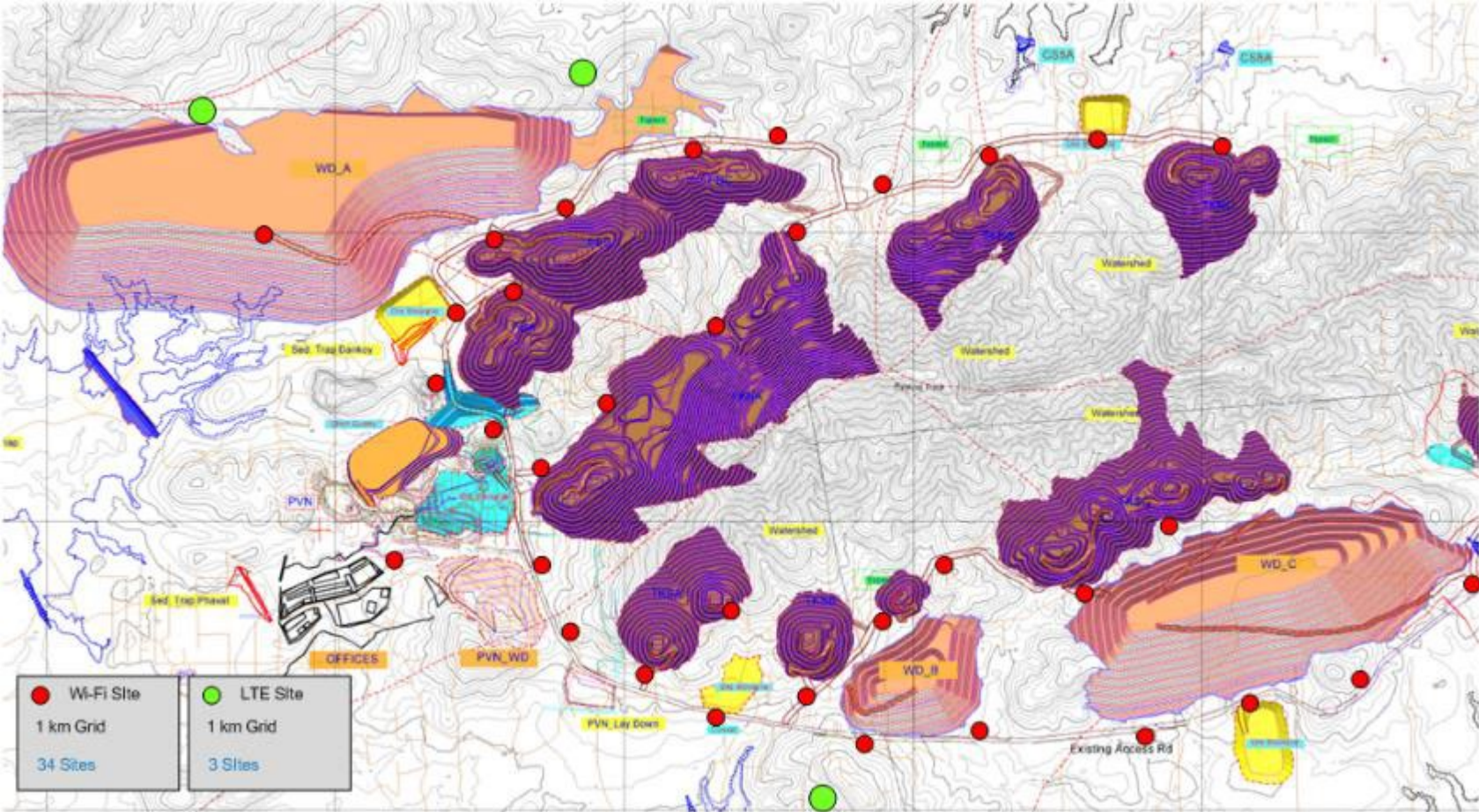


Concept #10

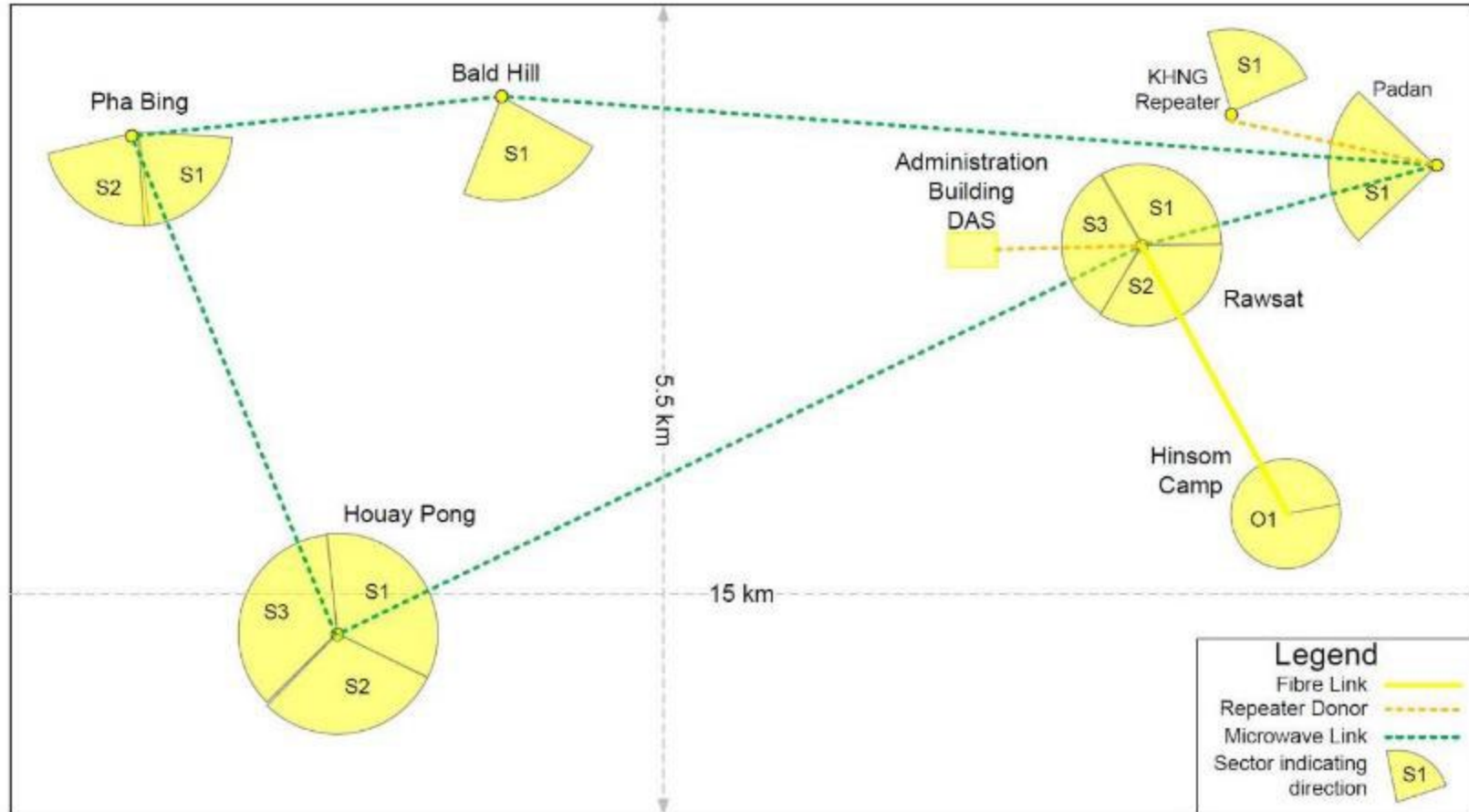
- The previous slide is all you need to know technically to develop an NPN business case !



Wi-Fi Vs 4G – number of sites



Final design



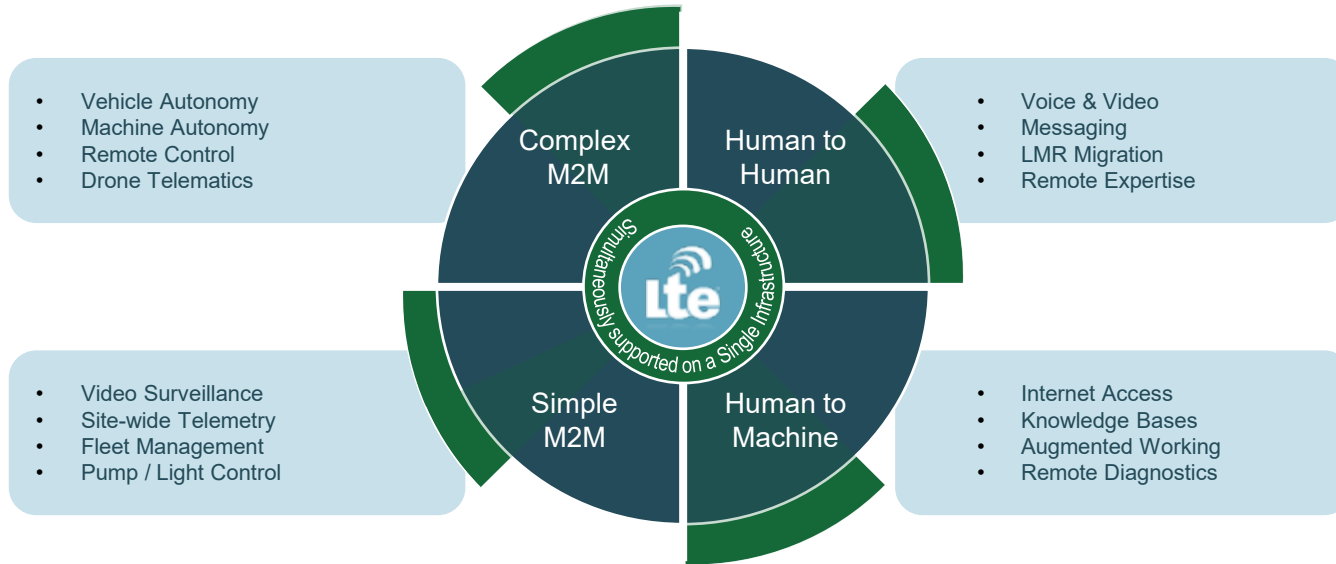
Concept #11

- Height (Trigonometry) is your friend
- The most expensive things in an 4G/5G network are....
 - Power
 - Concrete & steel
 - Site access
 - Backhaul (for remote locations)



Concept #12

Remember the 'Wheel'



Concept #13

■ 4G ≠ Wi-Fi ++

- Remember the differences – QOS, Distance, scale
- Not 'Wi-fi on steroids'
- Wi-Fi 6 has some new features however



The 'Achilles heel' of 4G/5G - Regulatory & Spectrum



Regulatory

- In Australia, fully private 4G/5G networks are supported by the Government Regulator (ACMA).
- In some countries, private networks are ONLY allowed to be 'owned' by the 'mobile carriers'.
- These restrictions have limited growth in some countries (Sweden, much of South America, etc) to the mobile operators who have limited expertise.

Spectrum

- In Australia, generally mobile spectrum is available in regional & remote areas.
- Currently the legacy mobile carriers have an effective monopoly on spectrum in urban areas of Australia.
- Some countries (e.g. Germany & Japan) have had spectrum allocated nationally to private networks.
- Uncertain future for urban spectrum allocations in Australia regarding private networks

Some current areas of hot industry debate ?

- Are traditional mobile operators able to build private 4G/5G networks for industry ?
- Will regulators make provisions for this evolving technology – especially for spectrum in urban environments ?
- Will spectrum for Public safety use be made available for private 4G/5G?
- When/if will TETRA/P25 be replaced by 4G/5G ?
- Role of UHF/VHF ?
- Will Open RAN cause disruption to traditional vendors
- Role of Chinese vendors ?
- Impact of Wi-Fi 6 on 4G/5G ?
- Are there new ways of revenue generation for consumer network operators?



Concept #14

- 4G/5G is not perfect !
 - Remember the differences – QOS, Distance, scale
 - Not always an option in some locations – spectrum & regulatory

The Take away message.....

- These 14 concepts will give you a framework for understanding everything else in 4G/5G
 - If you hear something that conflicts with one of these concepts.... It's probably wrong.

Questions & Break ?



4G - Solutions specifics



Industrial Use Cases – Typical scenarios

- **Use cases:**

- Smart collaboration (Text, Voice, Video), PTT
- Automated Guided Vehicles (Latency <50ms)
- Surveillance Cameras (Latency <50ms)
- Human Machine Interface (Latency <50ms)
- Remote Expert (Latency <50ms)
- Augmented Reality (Latency <50ms)
- Sensors, Actuators (Latency >100ms) – CATM1 & NB-IoT

- **Coverage: 100s m² – 100 km²s**

- Indoors and/or outdoors
- Above and/or below ground

- **Number of UE: 10s-10,000s**

- **Bandwidth per UE:**

- Low: < 200 kbps
- Medium < 1Mbps
- High: > 20Mbps



A typical stand alone NPN at a mine site



KCGM – ‘Super Pit’



Vocus NMS

15

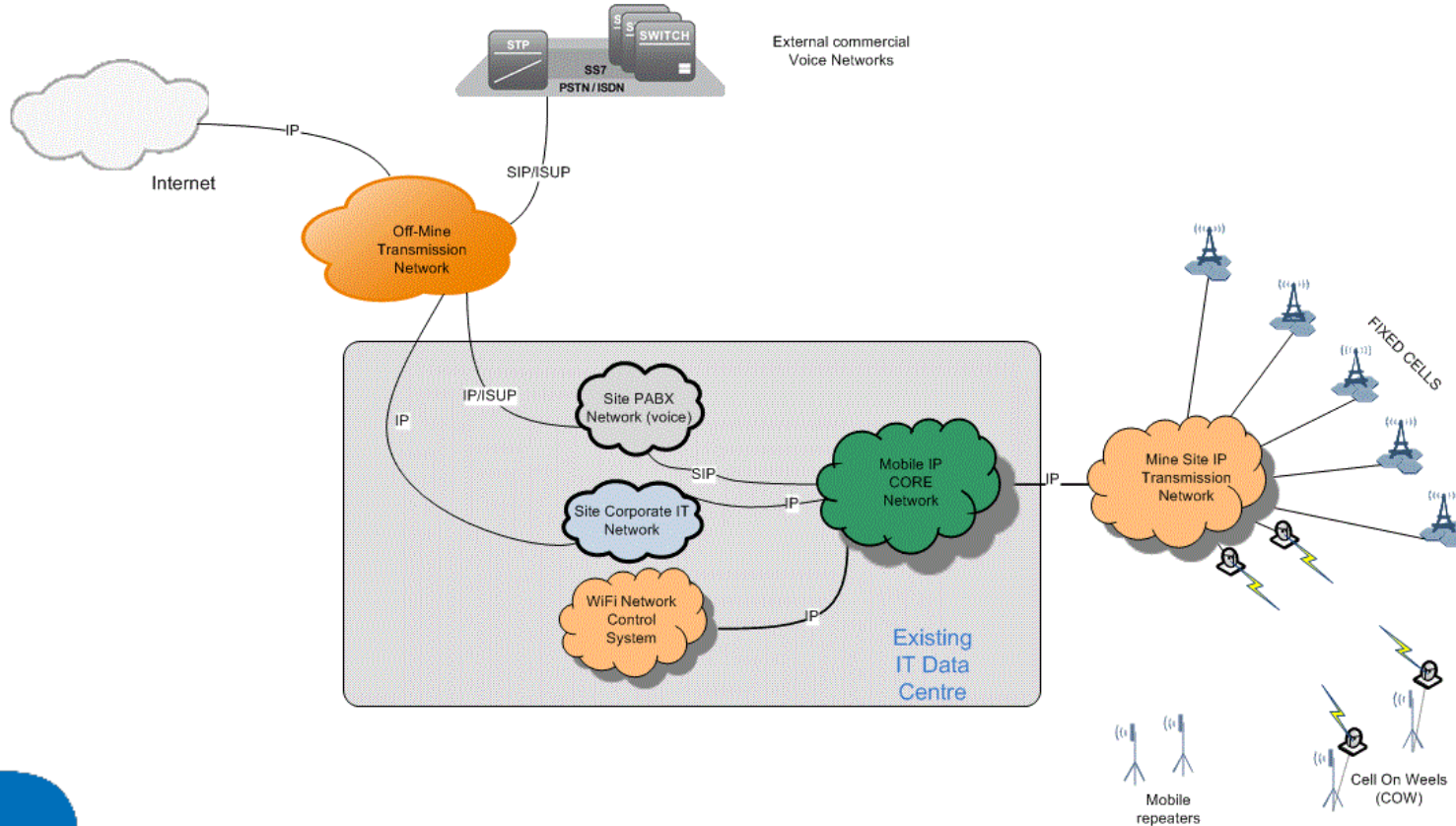
Core Layer RAN Layer UE Layer UE Labels Show Heatmap Device Count KPI

Current timestamp: 28/05/2024 00:00:00

RSRP thresholds	
Excellent	Above -90dBm
Good	[-100dBm] - [-90dBm]
Normal	[-110dBm] - [-100dBm]
Fair	[-120dBm] - [-110dBm]
Poor	Below -120dBm

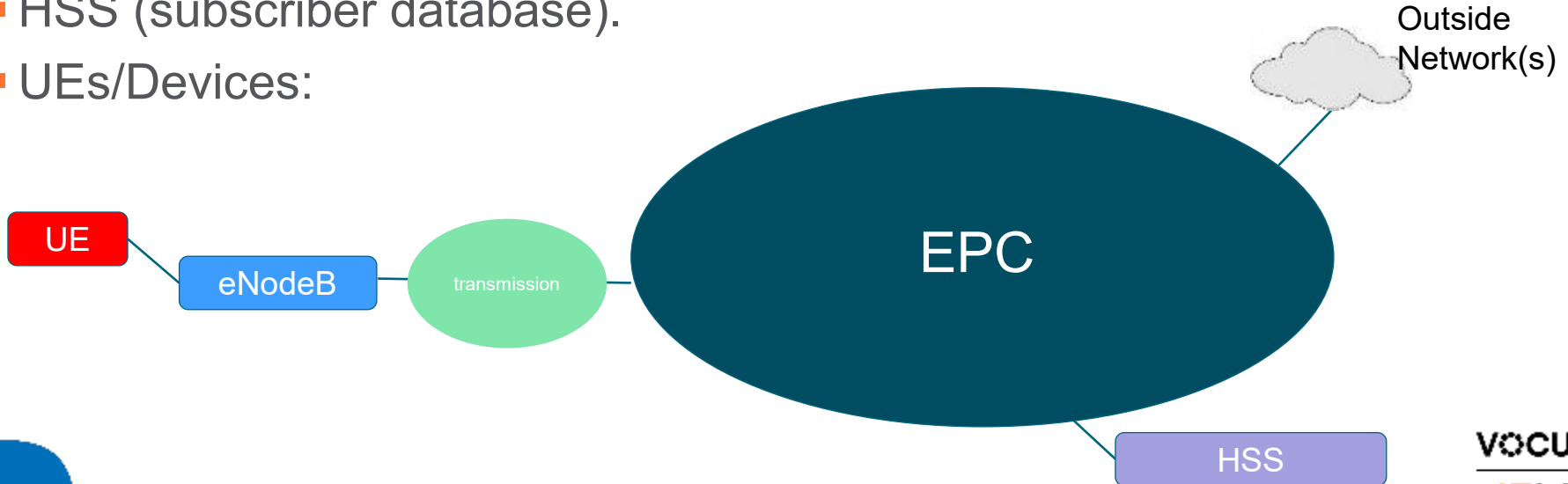


Typical private 4G/5G Network Overview



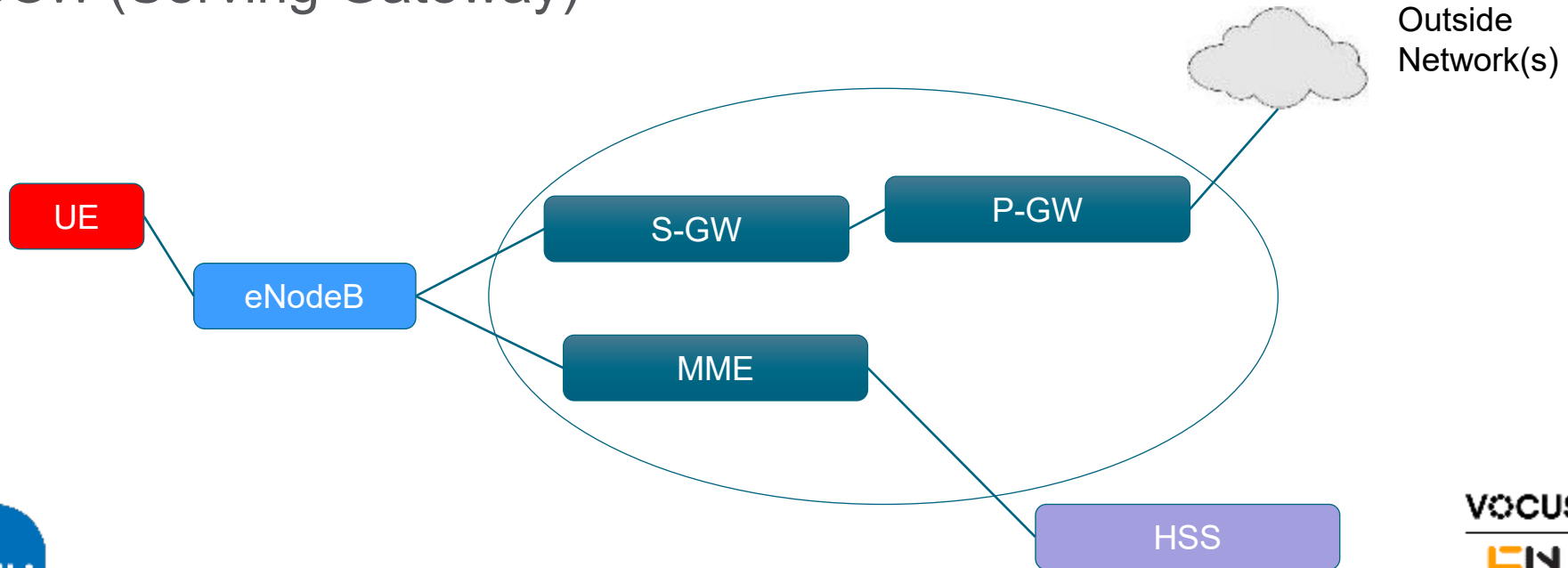
Components in a 4G Network

- Radio (eNodeB).
- Transmission network (fibre & MW):
- EPC (Mobile Core).
- HSS (subscriber database).
- UEs/Devices:

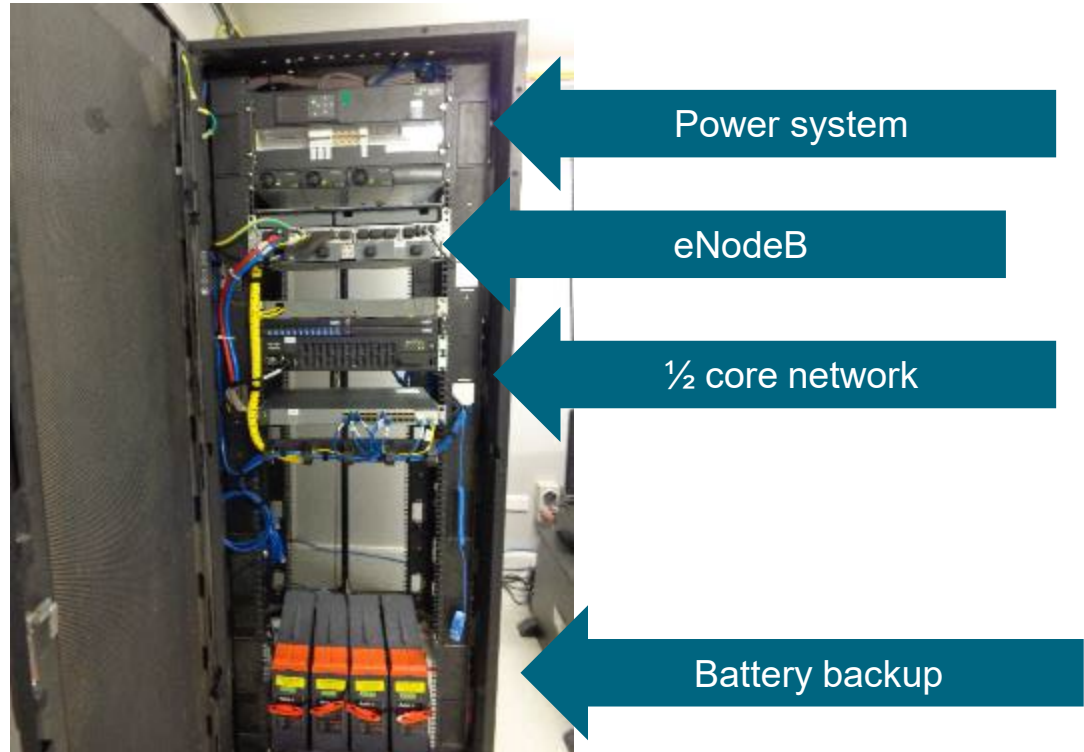


Components within the EPC

- MME(Mobility Management Entity)
- PGW (Packet Data Network Gateway)
- SGW (Serving Gateway)



Example of a real core network



Different Base station types

- Fixed large Mobile base station (eNodeB) [Macro site]
 - Used to provide permanent, long distance, high capacity coverage
 - Expensive due to civil works components (power, tower, etc)
 - High power consumption (1000w)
- Fixed small Mobile base station (eNodeB) [Mini site]
 - Used to provide small area coverage (1-2km)
 - Typically used in camps, buildings, etc
 - Quick & easy installation, 240v or 12/24/48v DC power
- Mobile 'COW' Cell On Wheels [Trailer]
 - To provide medium term & short distance coverage
 - Takes a day to move/setup
 - Medium power consumption. Can be solar/wind powered



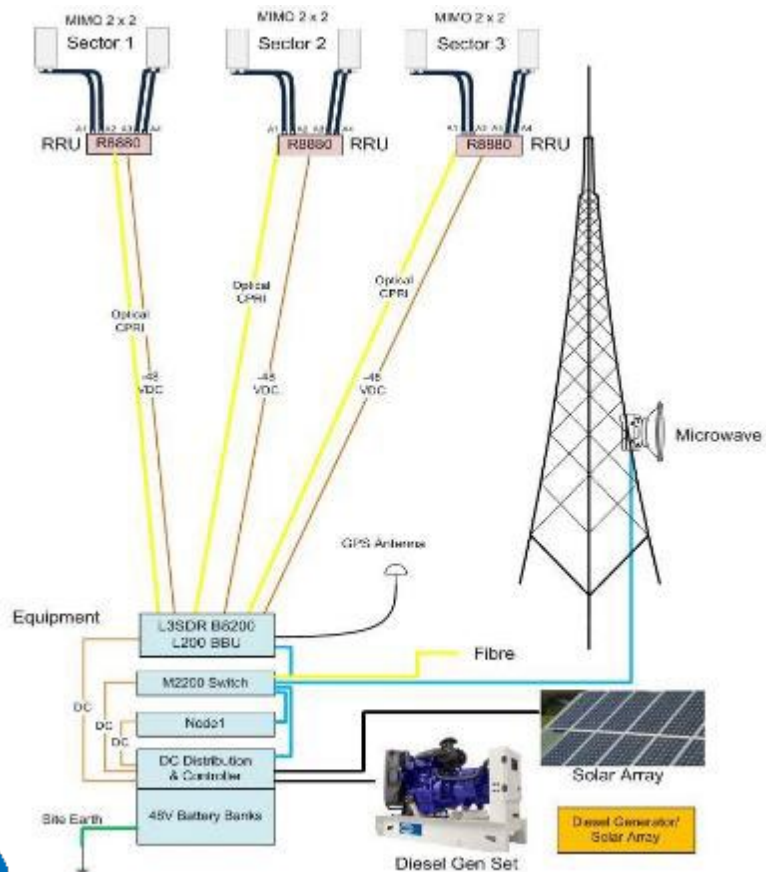
Field deployment example of trailer/COW



Rapid deployment Mini eNodeB on 10m tower



Macro eNodeB



Questions & Break ?





Public safety discussion

Technology is the easy part....



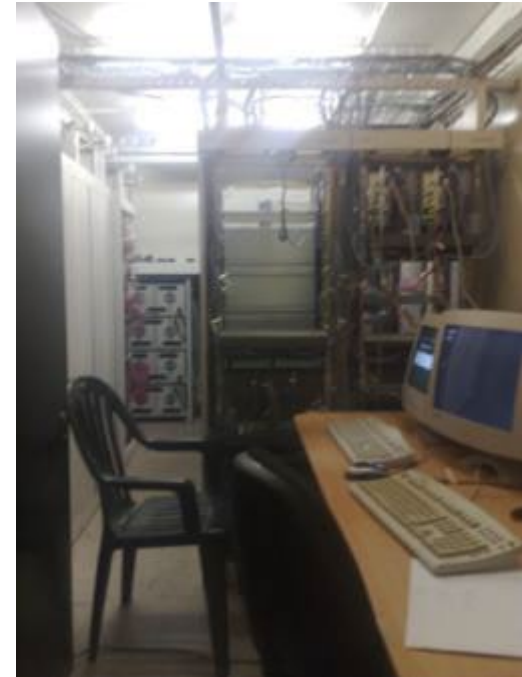
Traditional mobile DR (≈public safety) solutions

➤ COW [Cell on Wheels]



Traditional mobile DR solutions

- Total exchange replacement



Traditional mobile DR solutions

- Major exchange replacement



Traditional mobile DR solutions

- Small replacement network



Complexities.... Non-Deterministic

- Public Safety (Disaster Recovery) networks are completely different to consumer networks.
- Critical to understand that the architecture required for a Public safety network should be completely different to that of a consumer network.
- The reason for the above is that in public safety:
 - Can have key infrastructure destroyed (burnt, blown up, etc)
 - You don't know 'where the plane will crash' so coverage requirements are unknown.
 - You don't know 'how many people involved' so capacity requirements are also unknown,

Complexities.... It gets worse.....

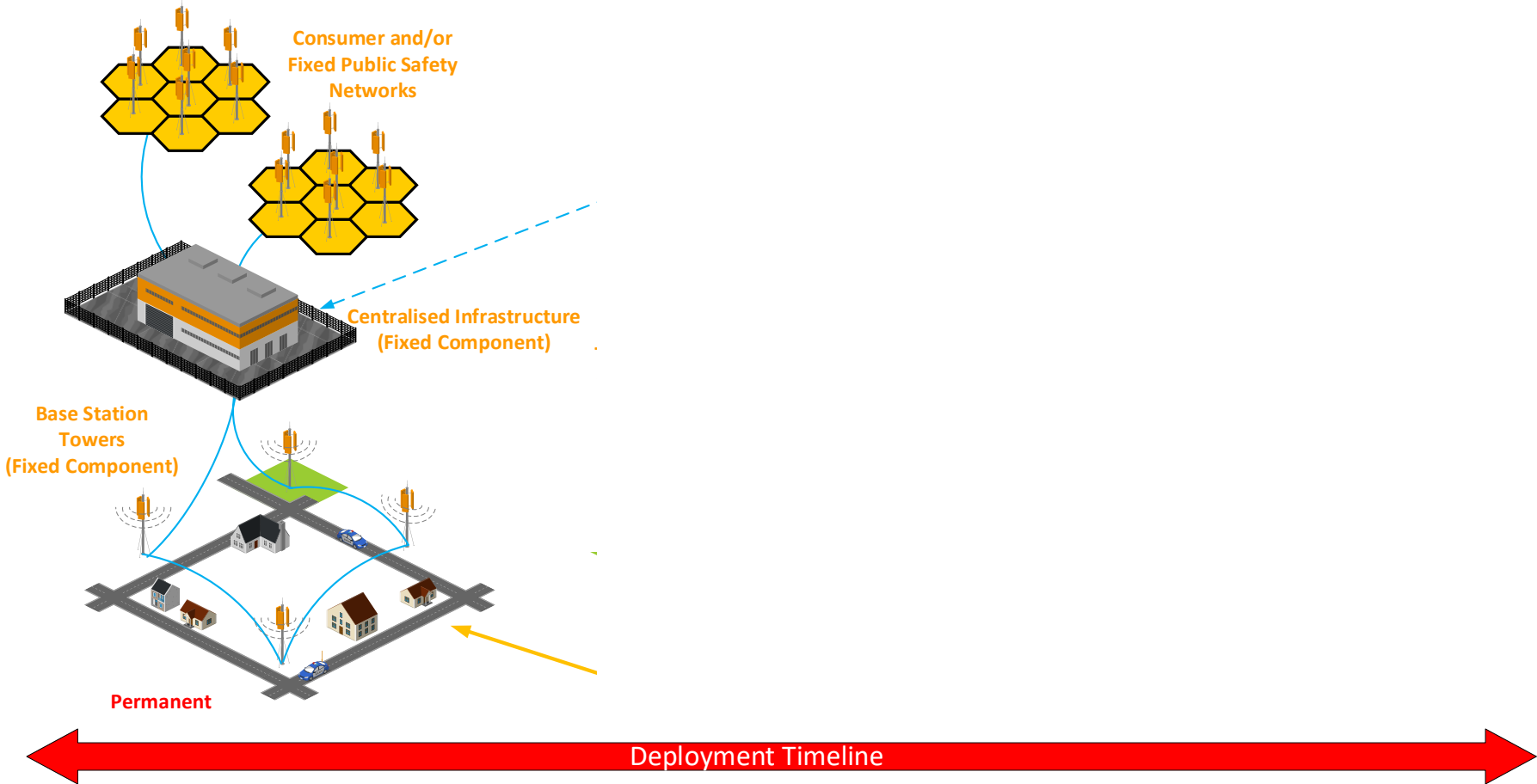
- Consumer network owners see it all as a revenue opportunity.
- Consumer networks owners don't understand the requirements.
- Getting everyone aligned is hard
- Spectrum – unless Public safety agencies have their own spectrum - it's hard
- Vendor misalignment.
- Politics – between everyone
- Technology is the easy part !

I cannot give guidance on any of the above

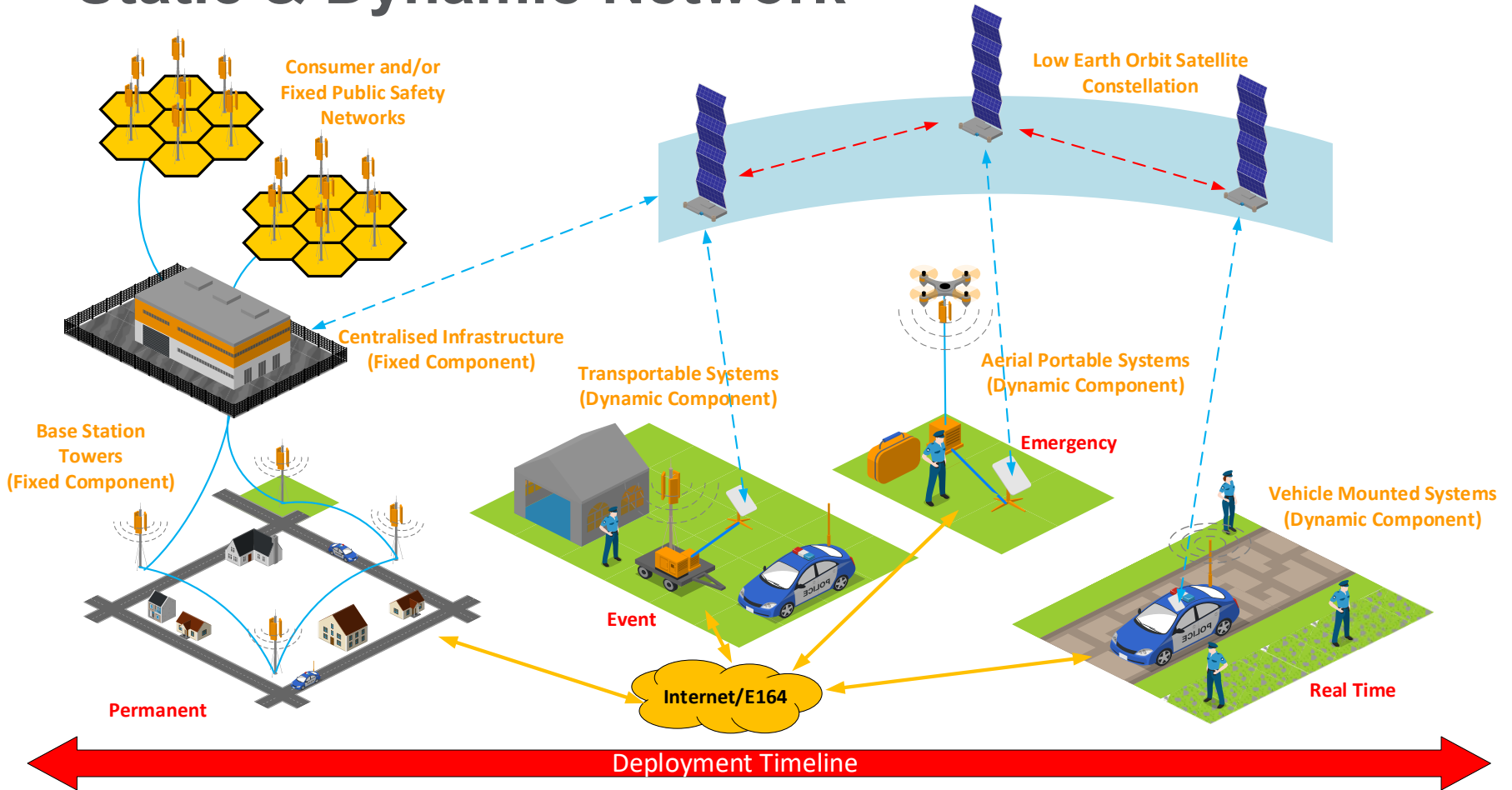
Breaking down the problem of the architecture....

- We see dividing the network problem into two domains
 - Static
 - Dynamic
- Then integration with existing consumer network(s)

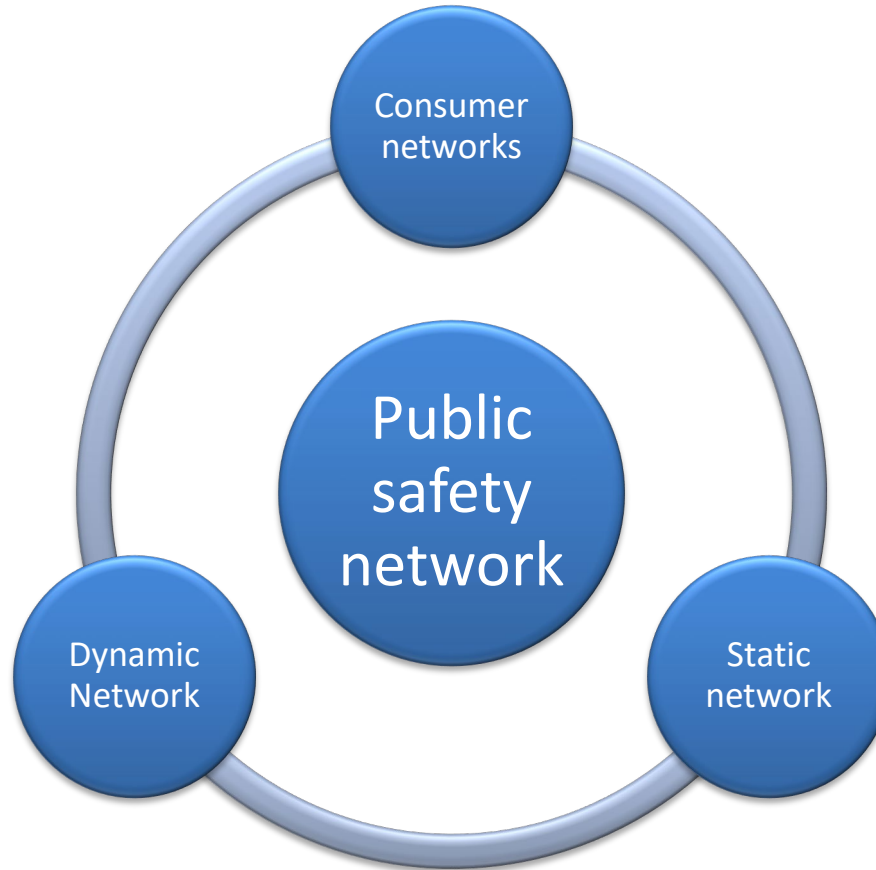
Static Network



Static & Dynamic Network



Public Safety Network – the building blocks





Height Illustration

Typical disaster recovery solution

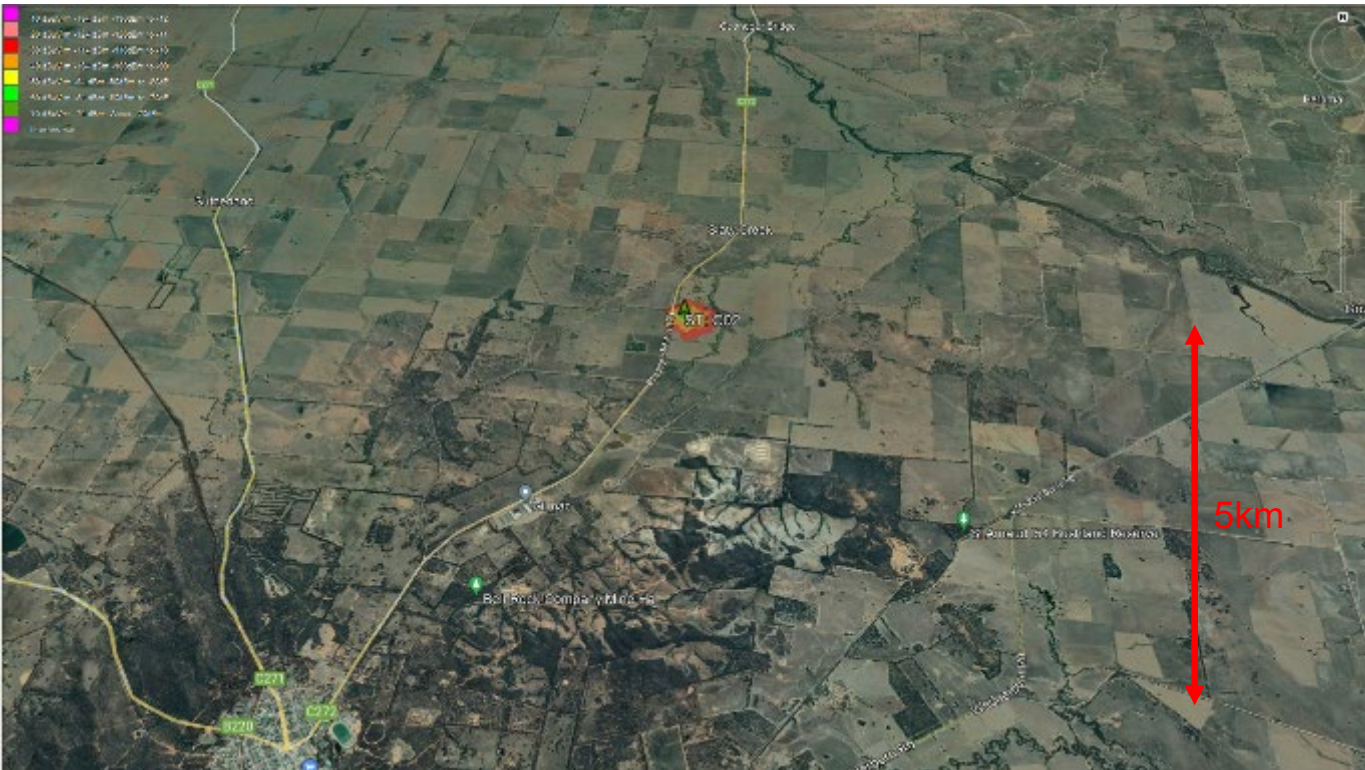
Antenna height – 5m



Rapid Deployment – Height matters

Antenna height – 5m

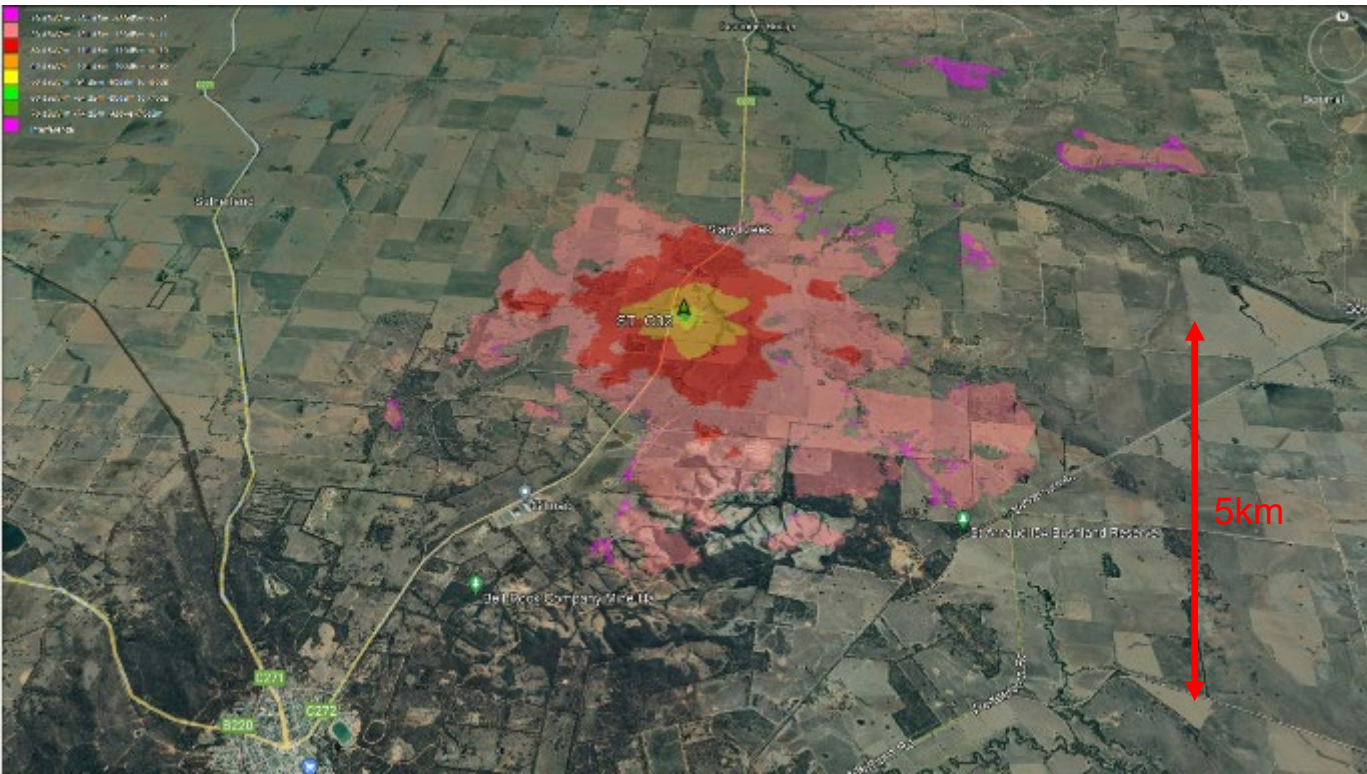
- 5w 2T2R eNodeB
- Victorian undulating
- Coverage width 500m



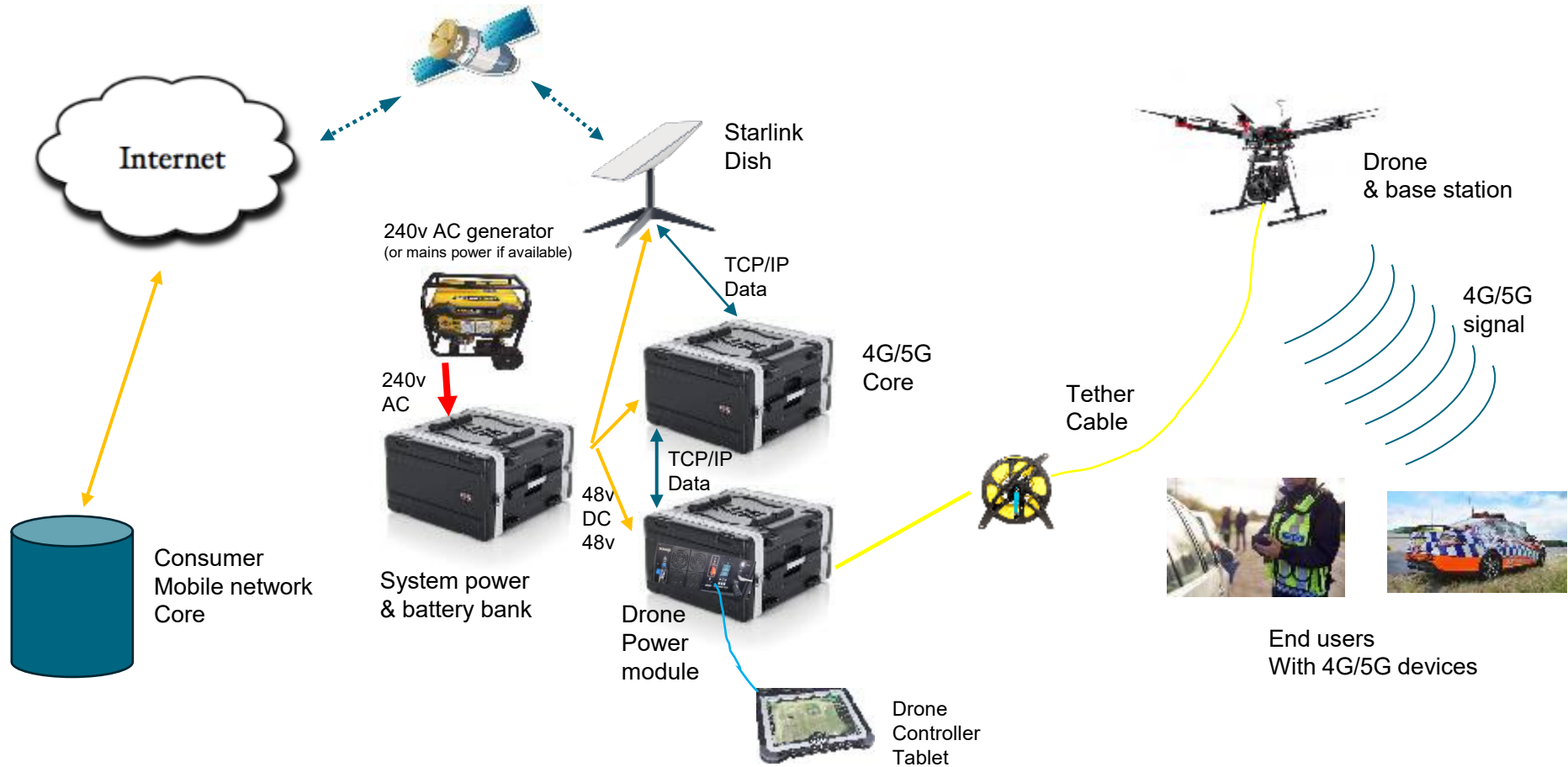
Rapid Deployment – Height matters

Antenna height – 20m

- 5w 2T2R eNodeB
- Victorian undulating farmland
- Coverage width 4km



Video



Questions & Break ?

A photograph of a coal mine tunnel. The scene is dimly lit, with bright lights from machinery illuminating the area. In the foreground, there are large, dark, textured piles of coal. In the background, a worker in a hard hat and safety vest is visible near a piece of heavy machinery. The tunnel walls are lined with wooden planks, and there are various pipes and cables running along the ceiling and walls.

5G Discussion & IoT

In the news – Capacity & Speed

- *“5G specs announced: 20 Gbps download, 1ms latency, 1M devices per square km”* – Technica Feb 17
- *“5G will be the key enabler of a new era that will affect every end user, the economy, and the society as a whole. It will make the probable possible by connecting everyone and every thing efficiently.”* – Nokia insight magazine.
- *“Telstra boss predicts 5G to be faster than NBN fibre”* – The West Australian 11 Jan 2018
- *“Going massive with MIMO”* – Jan 26 2018 Ericsson
- *“Samsung hits 1.7Gbps in 5G tests on a moving train”* – Fossbytes Dec 2017
- *“Did the 5G rollout in Wuhan damage the innate cellular defense cells of the population, putting the people at risk of complications and death from coronavirus?”* - Natural News April 21



Key Messages – 5G generally

- There is a lot of ‘hype’ in the market about 5G.
 - Sadly, it will not create world peace or end starvation.
 - Unfortunately much of the hype has to do with vendors (who are marketing to create new revenue streams) trying to encourage consumer demand (consume more data).
- 5G is just a small evolutionary step from 4G/LTE.
 - In contrast 3G/UMTS to 4G/LTE which was a large change in technology platform.
 - However the further push to standardisation and ‘open’ platforms means further multi vendor solutions and new vendor players.
 - RAN changes (standardisation of CPRI interface) potentially will disrupt the market commercially.
 - For the traditional mobile only vendors (Ericsson, Nokia, Huawei) a number of new vendor entrants (Microsoft, Amazon, etc) are now enabled to compete.
- The laws of physics & economics still remain valid.
 - To achieve the ‘advertised’ high bandwidth of 5G, lots of spectrum is required. (Due to physics)
 - To access ‘lots of spectrum’ this is generally in the ‘higher frequency bands’. (Due to economics & physics)
 - The ‘higher frequency bands’ means limited (typically 10-500 metres) cell site range (Due to physics)
 - Don’t let the ‘under test conditions’ results from vendors misguide you !



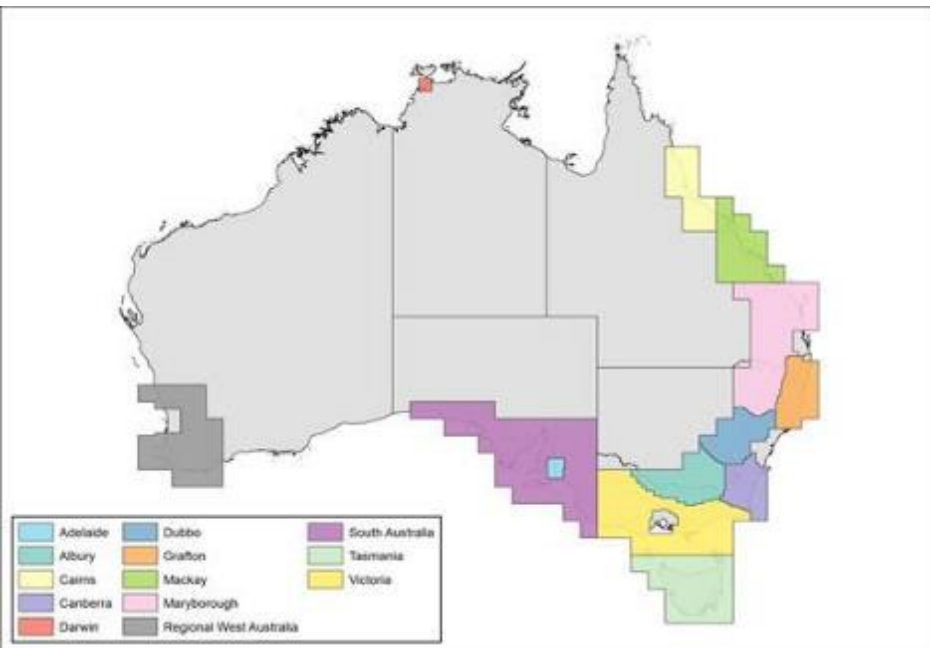
Key Messages – 5G

- '5G' is really a marketing term not a technical one. It is simply an arbitrary 'stake in the sand' of a set of continually developing standards.
- '4G' & '5G' are really evolutions of the ONE standard (3GPP).
- One does not replace the other, they are simply expansions to an established ecosystem that is constantly expanding.
- Backward compatibility is a fundamental characteristic – if you sent your Samsung S20 back in time 15 years – it would still work on the legacy mobile network of the time.
- 5G (and 4G) is a standard not a technology.



Regulatory & Spectrum – Australian context

Site location determine what options (if any) are available for private mobile networks.

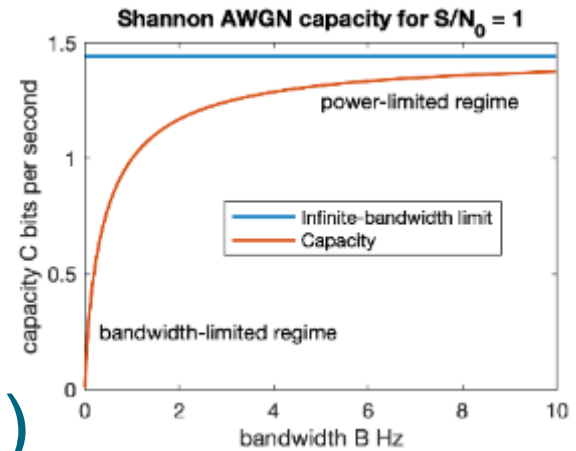
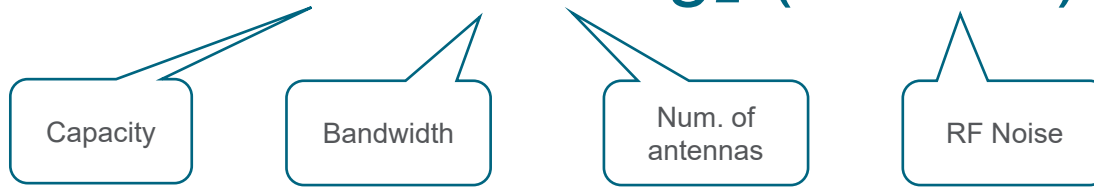


- In Australia for private networks, 5G is identical to that of 4G from a regulatory perspective.
- With some limited exceptions, private 4G/LTE is limited to Band 1 (2100 MHz) and Band 3 (1800 MHz).
 - These are 'Apparatus licences' which cover a geographical circle of 50km diameter.
 - They are FDD bands – 10 MHz + 10MHz is the typical size (with a max of 20 MHz + 20 MHz).
- For 5G, there are two spectrum groups.
 - The so called 'cm wave' band - Band 78 (3600 MHz).
 - Also the 'mm wave' bands – n257 (26 GHz) and N261 (28GHz)
- The key reason that 5G has potentially higher speed than 4G is that these new spectrum bands have larger bandwidths (60-200 MHz rather than 20-40 MHz).
- Some spectrum is allocated to NPN.

Maths beat marketing

Shannon's law:

$$C \approx w.n.\log_2 (1+SNR)$$

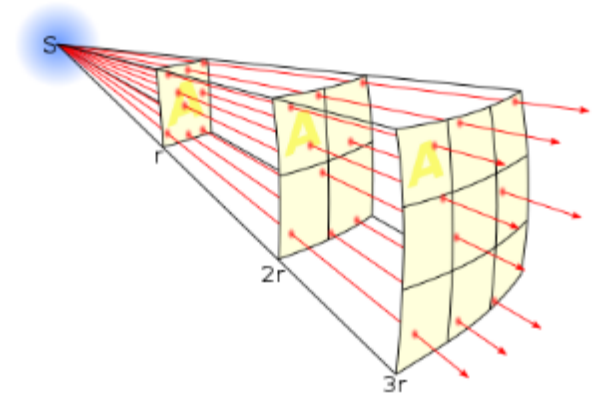


So fundamentally, 'speed' is determined by:

- 1) How much spectrum you have (bandwidth)
- 2) Number of antennas
- 3) Noise levels
- 4) 'Load' on network
- 5) Technology encoding (which is improving but has limits)

What frequency you use & distance matters !

$$\text{Free Space Path Loss} = \left(\frac{4\pi df}{c} \right)^2$$



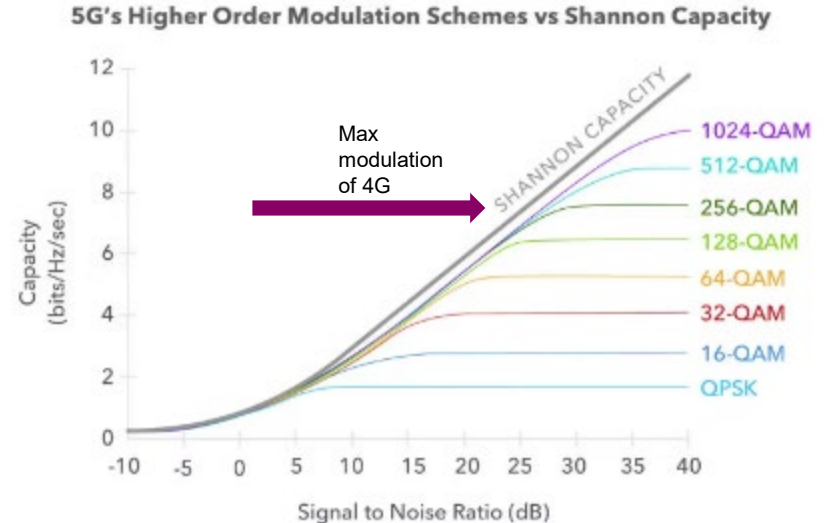
So key points :

- 1) Higher frequencies don't travel so far
- 2) Distance matters

So is 5G fundamentally faster ?

Well yes but not always as much as the sales people would like you to believe...

- 1) Physics (and the maths around it) finally wins....
- 2) In terms of bits/Hz/sec – it mainly has an impact with high SNR (see graph on right)
- 3) So while theoretically (based on encoding schemes available in 5G vs 4G) 5G has a higher efficiency, this is often difficult to achieve outside of near perfect (high SNR) environments.
- 4) In practical, real world terms:
 - When all else is equal (Bandwidth, # antennas, SNR)
 - The advantage of 5G encoding vs 4G is minimal (<10%)
- 4) Is primarily the bandwidth that makes the higher speeds.



Typical Radio Access Hierarchy 4G, 5G, Wi-Fi



Australia Industrial Wireless

		Common Terms	Typical Coverage (inter-site-dist.)	Typical spectrum (per network)	Typical DL (~user rate)	Optimal Service
	mmWave unlicensed 60 GHz	WiFi, WiGig. 802.11ad/ay	50 m	7GHz shared (2GHz channel)	5,000 Mbps	Point to point. Indoor.
	mmWave 24-50 GHz	Millimeter Wave	50-200 m	800MHz channel	2,300 Mbps	Hot-spot data, Point to multi-point NR-IIoT/URLLC
	Unlicensed 5-6 GHz	Wi-Fi 802.11ac/ax. LTE-U, NR-U	100 m	500MHz shared (80MHz channel)	300 Mbps	Hot-spot data, indoor, mesh
	Upper mid bands 3-4 GHz	C-Band, sub 6GHz, TDD, CBRS (US)	500 m	100MHz	290 Mbps	Supplementary data capacity
	Lower mid bands 1-3 GHz	1800/2600MHz, FDD or TDD	5,000 m	80MHz (3x20MHz ch)	120 Mbps	Urban Voice, data capacity.
	Low bands sub 1GHz	700-900MHz FDD. UHF, Digital Dividend	10,000 m	40MHz (2x20MHz ch)	80 Mbps	Voice, Data coverage. LTE-M (IoT).
	Low bands sub 800MHz	600-700MHz FDD. 2 nd Digital Dividend	10,000 m	20MHz	50 Mbps	Voice over NR. NR-IoT

* Depends on environment, site design, RF features (e.g. MIMO schemes)

* Depends on country specific regulatory allocation and number of operators

* Depends on # users, load, interference, etc. Not peak rate.

Key Messages – 5G evolution from 4G

- There are essentially two paths open:
- Phase1 – 5G NSA (Non Stand alone)
 - This is the path that almost all consumer network carriers have taken around the world.
 - The 5G RAN (called NR – New Radio) connects back to the existing LTE core.
 - The 4G RAN (eNodeB) provide signalling as a radio overlay to the 5G NR units.
- Phase2 - 5G SA (Stand Alone)
 - As of today in service around the world there are only a handful of such deployments in the consumer network space.
 - There is a new separate 5G core network and a new 5G RAN (same as the phase 1 RAN).
 - In this scenario there is no mixture of 4G/LTE and 5G Radios in the network.
 - There are currently very few private networks also.



Where would a 5G SA network be used in private networks – next 1-2 years ?

- In small sites (less than circa 1-2km²) where the site can have lots of small base stations.
- Where spectrum is limited to only the 5G cmW and mmW bands (so urban environments).
- Where there is a need for high bandwidth, high density applications.
- UEs options are a key determinant



Why are some vendors banned from 5G activities in some countries ?

- Consumer 1/2/3/4 G are all 'centralised' networks
 - These are easy(ish) to protect
 - So called 'Walled garden' security
- 5G networks are potentially 'decentralised' networks
 - Harder to protect using historical approaches
- Many vendors have their support outside of Australia
- Less of an issue for private 4G/5G networks



Questions & Break ?



A large yellow mining truck is positioned in a dimly lit underground tunnel. The truck is facing right, and its massive, treaded tires are prominent. The tunnel walls are rough and rocky, illuminated by overhead lights. A semi-transparent white banner is overlaid across the middle of the image, containing the text 'Steps to building your own...'.

Steps to building your own...

Industrial 4G/5G implementation models



Which to use varies on:

- Country specific regulatory environment
- Access to spectrum in area

Private 4G/5G

- Licensed or unlicensed spectrum
- Build & operate own network infrastructure
 - Core
 - Base Stations

Shared

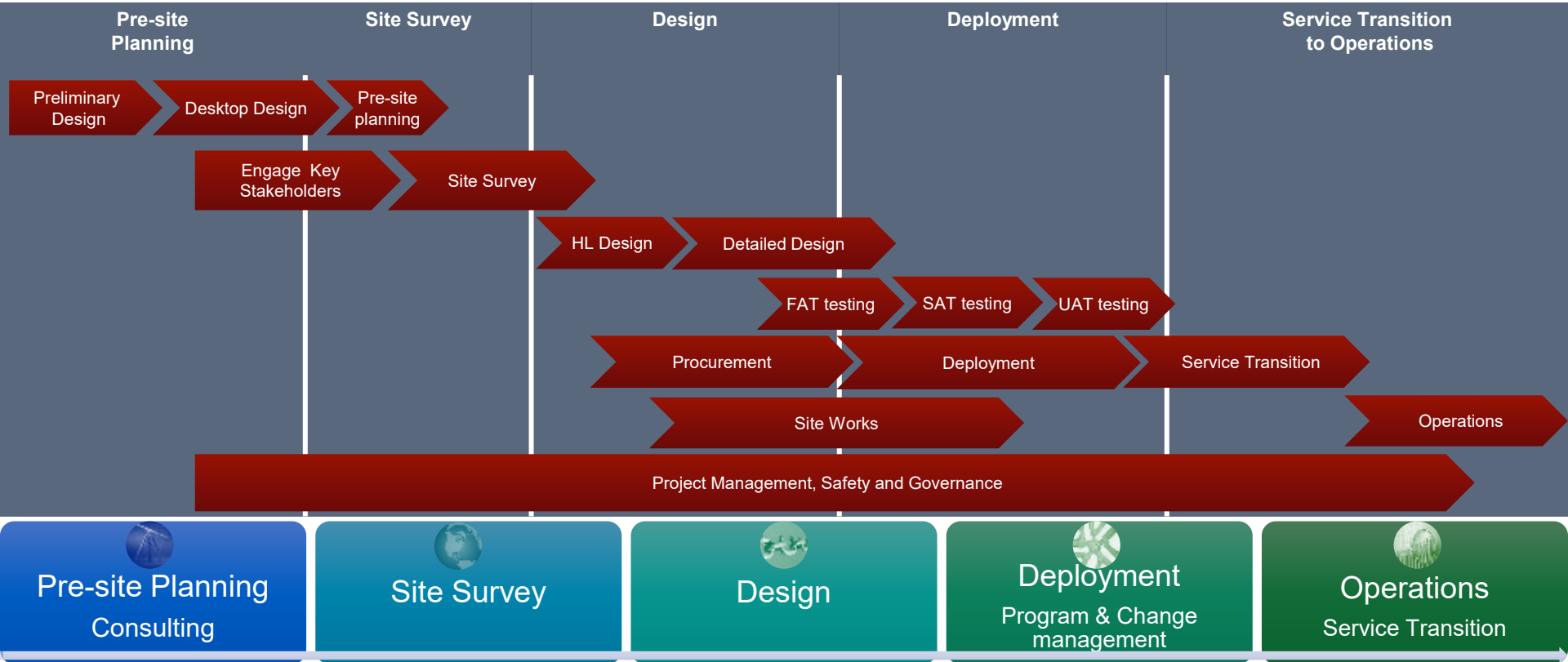
- Sub-licence spectrum from a mobile network operator
- Build & operate part/all the network infrastructure

Public 4G/5G

- Partner with a mobile network operator
- Extension of consumer network
- Alternatively 'network slice' to create a 'virtual' private network

Phased Deployment Approach

What does a wireless project look like?



WE HOPE YOU ENJOYED THIS SESSION

If you have any questions that haven't been answered, please email them to us at info@arcia.org.au with the email heading 'PDT program question' and we will respond.

