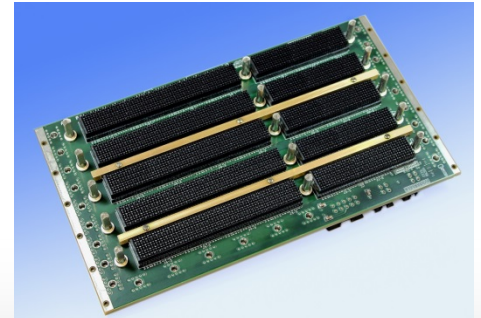
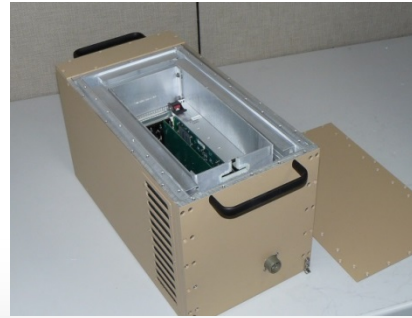
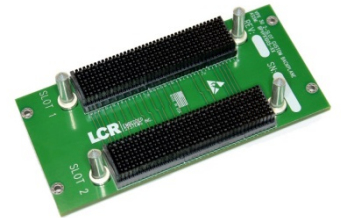
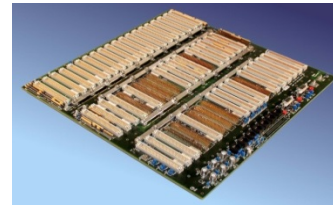
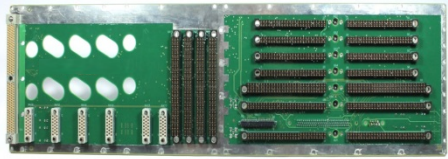
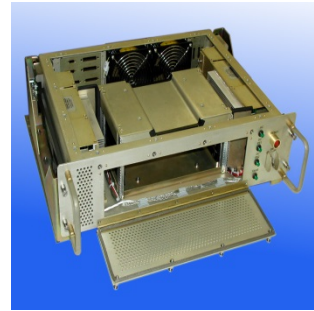
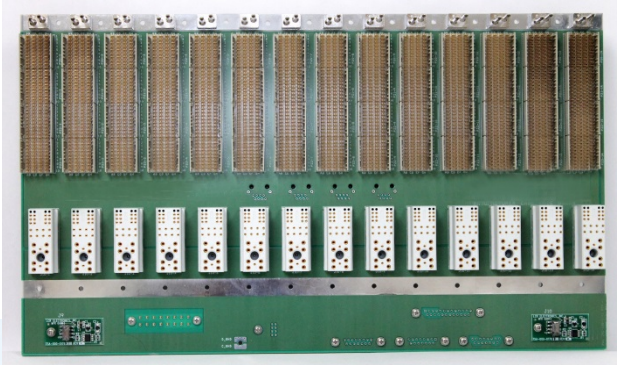
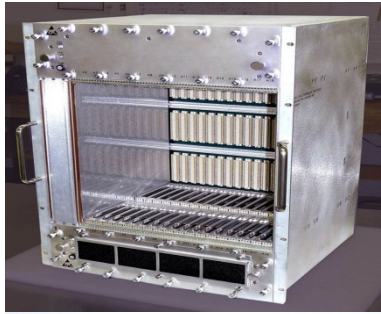


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Potential Topics

- Shipborne Shock & Vibration
- How VITA 64.11 will be used for remote management
- Trends in Application
 - Radar
 - Communications - LTE

LTE for Rugged Environments

- Potential markets
- Advantage of LTE
- Use cases
- Challenges



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Potential Rugged LTE Users

- DoD:
 - US
 - Foreign
- First Responders: FCC mandated migrate to LTE. ITU recommended use of LTE for First Responders world wide
- Remote Locations: Mining, Off Shore Oil Wells etc.
- Commercial Airlines

Advantages: User Interface

- Need to understand the typical user

Active Duty Age Profile (DOD 2013)

Age Distribution of Active Duty Force						
Service	18-21	22-30	31-40	41-50	51-59	Average Age
Army	18.3 %	48 %	25.6 %	7.9 %	0.7 %	29
Navy	18.6 %	46 %	26.3 %	8.3 %	0.8 %	29
Marine Corps	36.9 %	46 %	14 %	3.1 %	0.2 %	25
Air Force	14.4 %	46 %	28.3 %	10 %	0.6 %	30
Coast Guard	12.2 %	48 %	27 %	12 %	1 %	30

Latest JTRS User Equipment



AN/PRC-154
1.7LBS



AN/PRC-155
14LBS

Latest LTE User Equipment

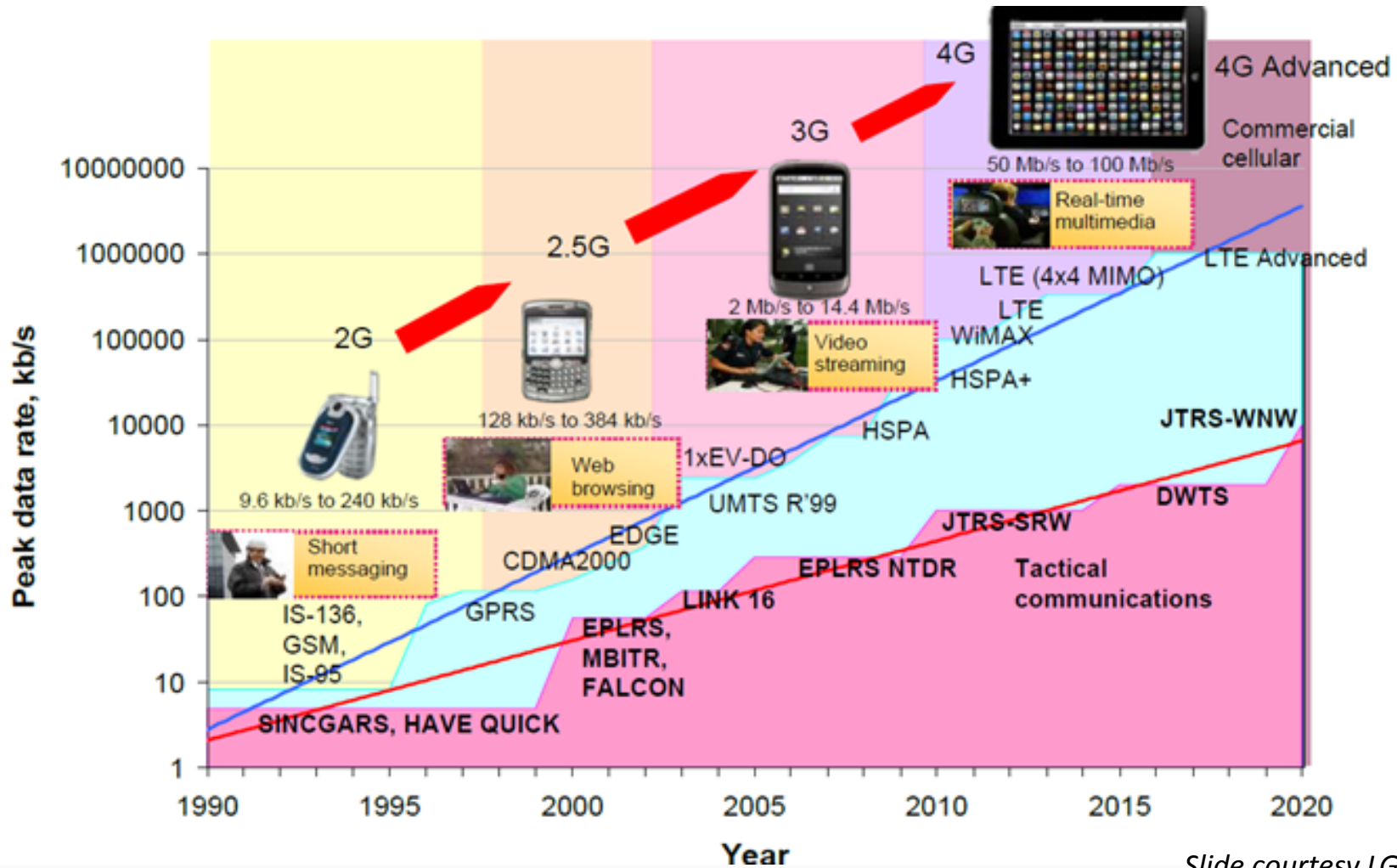


16
4.45 oz



Galaxy Note 4
6.2 oz

LTE vs Military Radio Bandwidth



Slide courtesy LGSi



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Advantages: Cost

- DoD would need ~ \$6B to develop ground up technology (based on JTRS development cost)
- LTE
 - Commercial technology that has a long term road map
 - Expertise is available in the industry
- Handset cost
 - AN/PRC-154 \$2850
 - Galaxy Note 4 \$749

LTE Technology

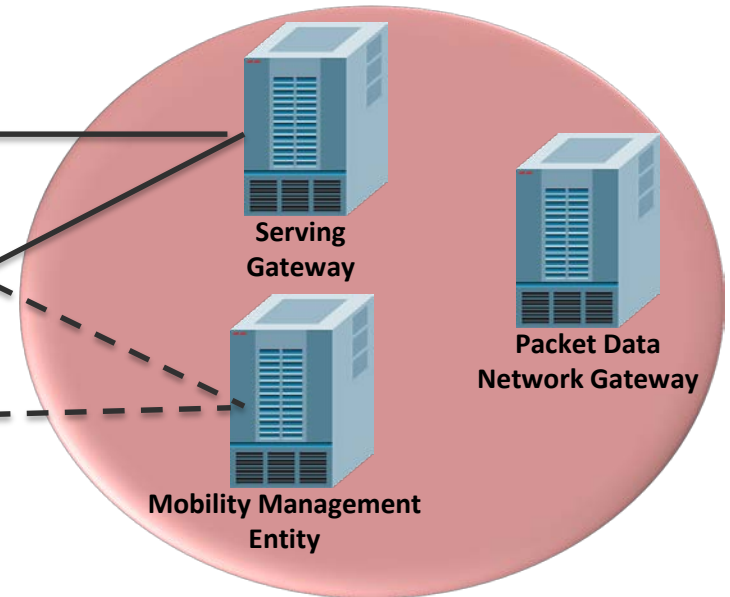
User Equipment



eNodeB



Evolved Packet Core (EPC)



RAN (Radio Access Network)
eNodeB: Handles the air interface and conversion to wired network

Evolved Packet Core (EPC):
Handles the call routing and switch



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Use Cases: Fixed Location

- Large Scale
 - Base Protection
 - Large Scale Disasters where infrastructure is destroyed
- Support 100's – 1000's of users.
- Supports EPC, eNodeB and may support remote eNodeB
- Connects to network via backhaul (Microwave or Satellite)



COW (Cell on Wheels)

Use Cases: Highly Mobile

- Airborne based
 - Available for a limited amount of time
- Supports 10s of users
- May consist of only eNodeB, backhaul via satellite to EPC



Use Cases: Ground Mobile

- Tactical Based
 - Vehicle or Man pack (batteries)
- Supports 10's of users
- Contains eNodeB, and EPC
- Connect to other network vs via various methods
- Swarming Technology



Challenges: Radio Bands

- The LTE was designed to work on certain frequencies called Radio Band
- ~ 44 Radio Bands were created
- Band 14 in the US is for public safety
- There is no open band in the US that supports LTE

FDD LTE BANDS & FREQUENCIES		
LTE BAND NUMBER	UPLINK (MHZ)	DOWNLINK (MHZ)
1	1920 - 1980	2110 - 2170
2	1850 - 1910	1930 - 1990
3	1710 - 1785	1805 - 1880
4	1710 - 1755	2110 - 2155
5	824 - 849	869 - 894
6	830 - 840	875 - 885
7	2500 - 2570	2620 - 2690
8	880 - 915	925 - 960
9	1749.9 - 1784.9	1844.9 - 1879.9
10	1710 - 1770	2110 - 2170
11	1427.9 - 1452.9	1475.9 - 1500.9
12	698 - 716	728 - 746
13	777 - 787	746 - 756
14	788 - 798	758 - 768
15	1900 - 1920	2600 - 2620
16	2010 - 2025	2585 - 2600
17	704 - 716	734 - 746
18	815 - 830	860 - 875
19	830 - 845	875 - 890
20	832 - 862	791 - 821
21	1447.9 - 1462.9	1495.5 - 1510.9
22	3410 - 3500	3510 - 3600
23	2000 - 2020	2180 - 2200
24	1625.5 - 1660.5	1525 - 1559
25	1850 - 1915	1930 - 1995
26	814 - 849	859 - 894
27	807 - 824	852 - 869
28	703 - 748	758 - 803
29	n/a	717 - 728
30	2305 - 2315	2350 - 2360
31	452.5 - 457.5	462.5 - 467.5

Challenges: Security

- Military Communications need to be secured.
- DoD has a preference for Software Defined Radio
- Potential Solutions
 - Unique Encryption on UE and eNodeB
 - Implement and SDR Front end
 - Hide in plain sight

Where is it going?

- DoD:
 - US: Some LTE has been deployed. Will move slowly, some applications will have and SDR front end
 - Foreign: Some will move more to LTE
- First Responders: Moving forward, but limited by funding
- Remote Locations: Radio Band Challenge
- Commercial Airlines: