5G – the future of networking
A military perspective

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Outline

• History
  – wireless communication in the old days
  – 1G – 4G
• 5G
• Military scenarios
• Summary
How it all started...

- Mechanical communication systems
- Charles Wheatstone developed a method to transmit electrical pulses over a metallic cable in 1838
- In 1840, Samuel Morse devised his code
- The first telegraphic Morse code messages were passed in 1844 between Washington and Baltimore
- The electric telegraph rendered mechanical systems useless, however, there were problems...
Problems in military communication

- Deficiencies in power supply
  - required frequent retransmissions
- Transmission time up to 24h
- Interference
  - "send reinforcements, I am going to advance"
  - "send three and four pence, I am going to a dance"
- Inflexible system
  - relied on cables
The wireless era

• James Clerk Maxwell proposed an idea for wireless communication in the 1860s
  – electro-magnetic waves can be propagated in space and travel at the speed of light
• Heinrich Hertz demonstrated electro-magnetic wave propagation over a few metres in 1888
• By the 1890s, practical wireless sets were built
  – Royal Navy officer, Captain H.B. Jackson
  – Italian entrepreneur, Guglielmo Marconi
The great European naval race

• Germany vs. Great Britain
• Also civilian maritime trade expanded
• Marconi saw a potential business area
  – communication ship-to-ship and ship-to-shore
• By 1900 the British Admiralty purchased 50 sets of Marconis products
  – 42 for ships and 8 for shore stations from Dover to Scilly Islands
  – range over 50 miles; 10 words/minute
  – explosive growth...
The network of the British Empire

• British Admiralty requirements were to be able to communicate simultaneously with a large number of ships spread over the worldwide oceanic area

• Building of worldwide chain of shore radio stations

• Intercontinental communications by cable
  – by the end of the 19th century the British Empire owned over 60%
1G

- From Meri-VHF, MTD, and ARP to...
- NMT (Nordisk MobilTelefon) in 1981
  - NMT 450
  - NMT 900
- Analog
- Range 2-30km
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2G

- Digital mobile services
- Circuit switched
- GSM or CDMA
- Enhancements to support data transmissions
  - GPRS
  - EDGE
  - HSCSD
3G

- Circuit switched and packet switched
- UMTS, CDMA2000, FOMA (WCDMA)
- Developed to be the follower of 2G
  - video conferencing was seen as the killer application
  - Japanese experience says downloading music is the killer application
- Flop in Europe due to spectrum license fees
- Succeeded in Japan and South Korea
  - these countries have a national infrastructure strategy
- The technology is complex and expensive
  - both for users and operators
- 4G is strongly on its way
  - e.g. India will go directly from 2G to 4G because they consider 3G to be developed but not cost efficient
4G

- Packet switched networks
  - the idea is to support IP traffic
- High-speed Internet to the pocket
- Bluetooth (?) (WPAN)
- WiFi (WLAN)
- WiMax (WMAN)
- MBWA (WWAN)
5G ??

• Assumptions
  – High-speed fiber networks
  – High-speed wireless networks
  – IPv6
  – Ubiquitous computing
  – Ad hoc abilities
  – Complete mobility
  – Applications

• The network is everywhere
  – various heterogeneous networks, but considered as one
  – virtual communities on top
virtual networks

fixed  mobile  wired  wireless

Access networks
Core network
Military scenarios
The threat environment

• The threats are global
  – Conflicts, terrorism, warfare (nations and non-nation organizations), organized crime,…

• International operations
  – NATO (Finland is a PfP country)
  – EU
    • E.g. rapid deployment forces (Germany, the Netherlands, Finland)
  – UN
  – …

• National defence
Net-centricity

• One core network
• Several access networks
• Service based architectures
• Multi-national coalitions
• Collaboration btw authorities

• Sensor networks
• Weapon systems
• Personal area networks
• ...

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Scenario 1

Performance monitoring:
- Heart rate monitoring of the troops
- Time in HR intervals (% of max)
- Shape of troop & expectancy to perform
- Temperature & humidity
- HR at rest
- The number of troops alive
Scenario 2

• Dynamic operational network
  – peer-to-peer method of info sharing
• Capability to "sense" an upcoming attack
  – let the enemy in
  – go into stealth networking mode
• Honey networks
  – keep your friends close, but your enemies closer
    (J.R. Ewing, character from Dallas)
  – control the enemy
    • what are his intents
    • feed him disinformation
Scenario 3

• Self-preserving networks
  – stealth networking
    • sense the attack, run and hide
  – if hit, automatically self-organize
    • self-healing networks
  – when new nodes become available, dynamically restructure the network

• In ad hoc networks nodes participated in routing, in self-preserving network nodes participate in management (in an ad hoc fashion)
Summary

- We have seen 1G-4G, but now what?
- 5G is important to Finland, because we have lost our status as an IT leader
  - we still struggle with a condemned 3G while the rest of the world is deploying 4G
  - 5G may get us back on track, IF we do something now
- Be creative; technology is just a tool, your imagination is the guideline!