DSP
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Broadband and 4G Communications - Architectures

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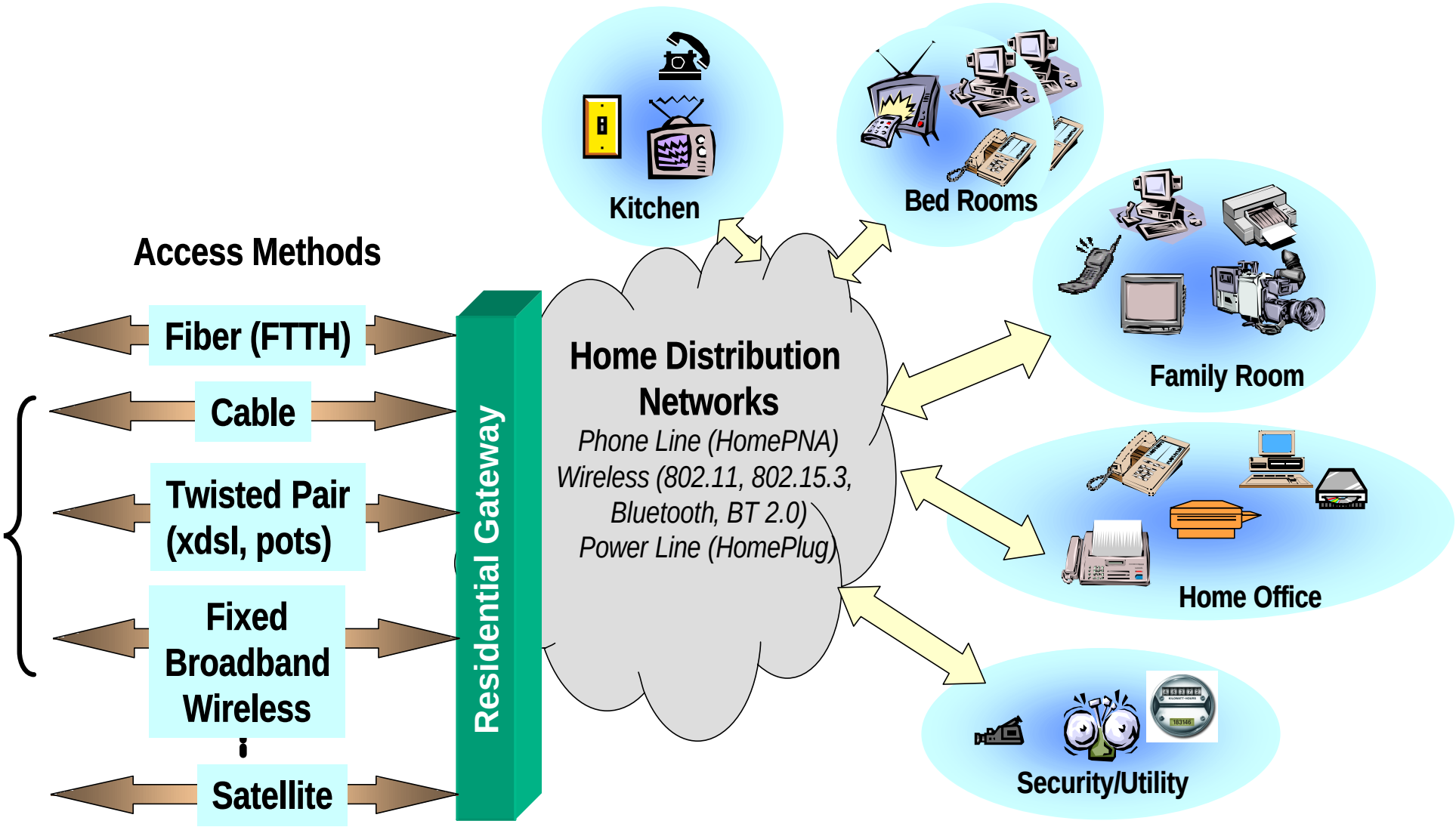
Broadband Communications at the Customer Premises



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Outline

- ***Environment/Trends***
- ***Communications standards***
  - Near-term, long-term roadmaps
- ***Communications architectures***
  - *Programmability vs. hardwired*
  - *Next generation IP blocks*
- ***Summary***

Environment

- ***Communications IC's***
  - ~50% of DSP market
  - Require a mix of hardwired and programmable DSP
  - > 100K logic gates per sq. mm.
  - Increased integration vs. recurring costs vs. non-recurring costs
  - Next generation IP blocks for re-use

- ***Communications standards***
  - **Wireless:** 3GPP/3GPP2, 802.16, 802.15.3, 802.11
  - **Wireline:** DOCSIS, ADSL, SHDSL, HPNA, HomePlug
  - Delays in deployment, heavy investment by incumbents
  - Technology spiritual battles involving circuit switched, ATM, and ***IP*** factions; ***OFDM vs. CDMA*** vs. single-carrier modulation; TDD vs. FDD

- ***Disruptive Technologies***
  - Advanced signal processing, multi-antenna, error correction coding, and MAC technology for increased capacity, rate, reach, and quality-of-service
  - Low cost 802.11 chipsets with QoS, 802.15.3 WPAN, Bluetooth
  - Re-usable communications architectures

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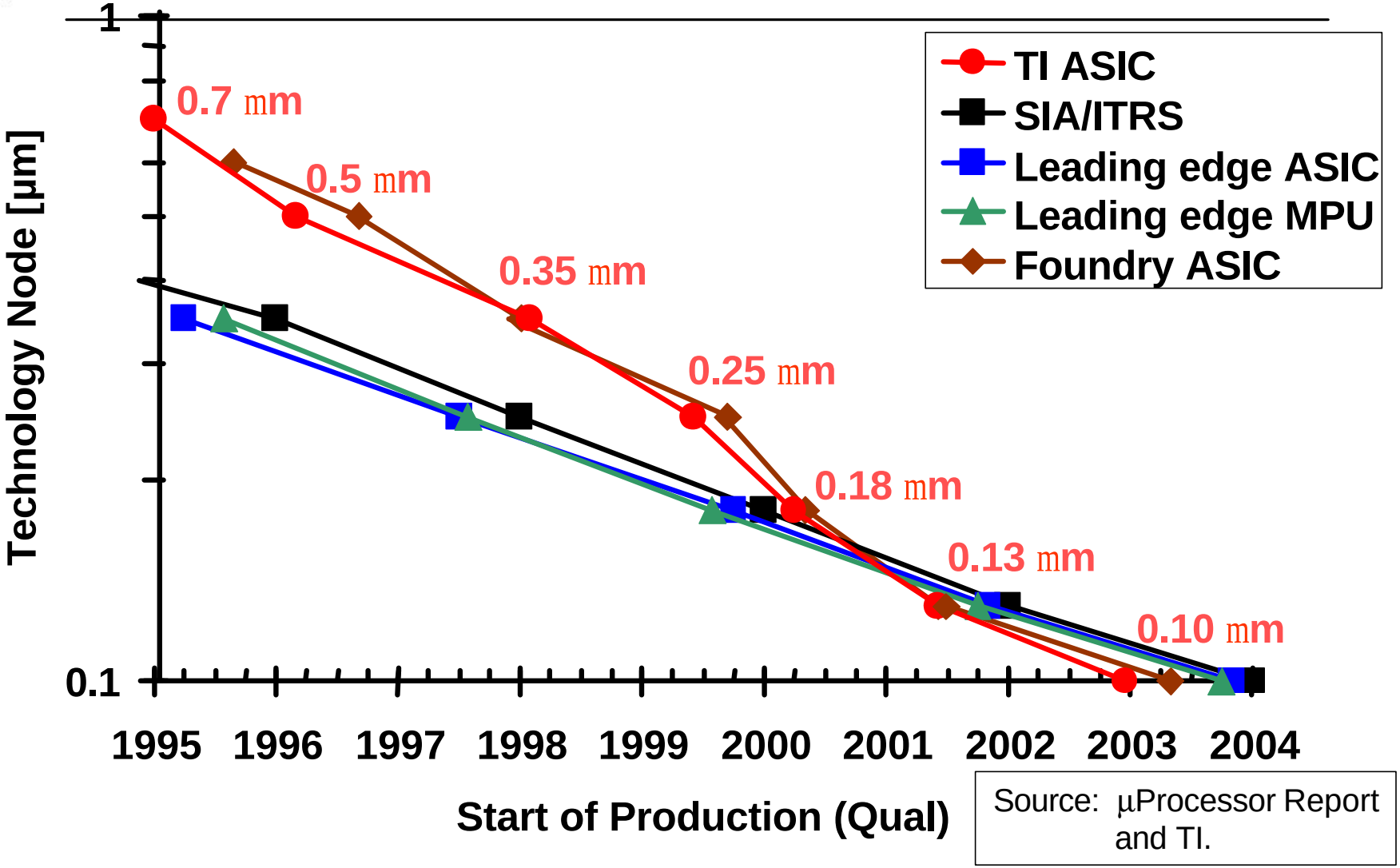
CMOS Scaling Roadmap Comparison



Source: µProcessor Report and TI.

Goal: *New technology node every 18 months, within the ITRS roadmap trend*

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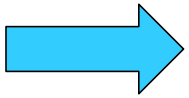

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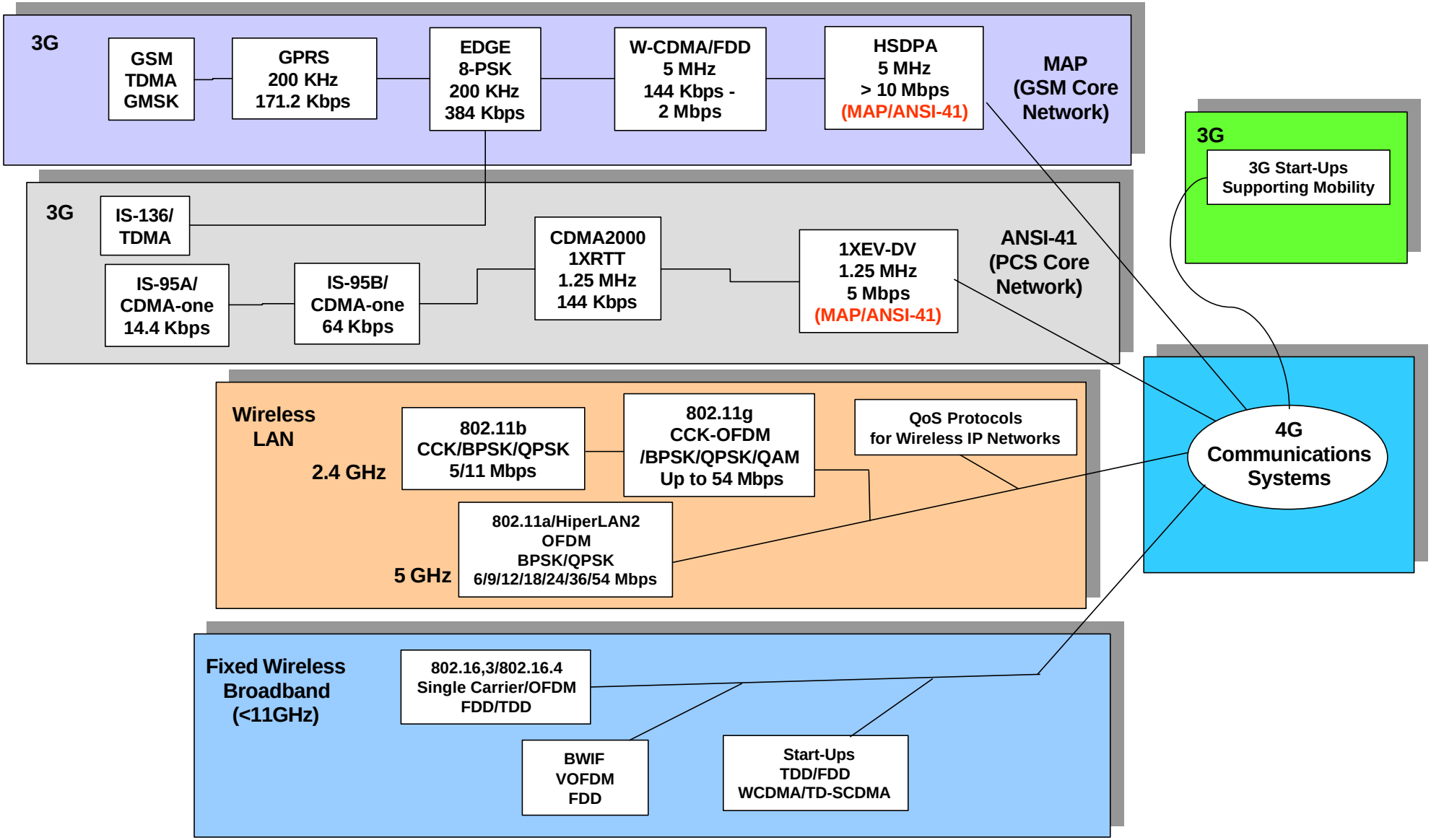
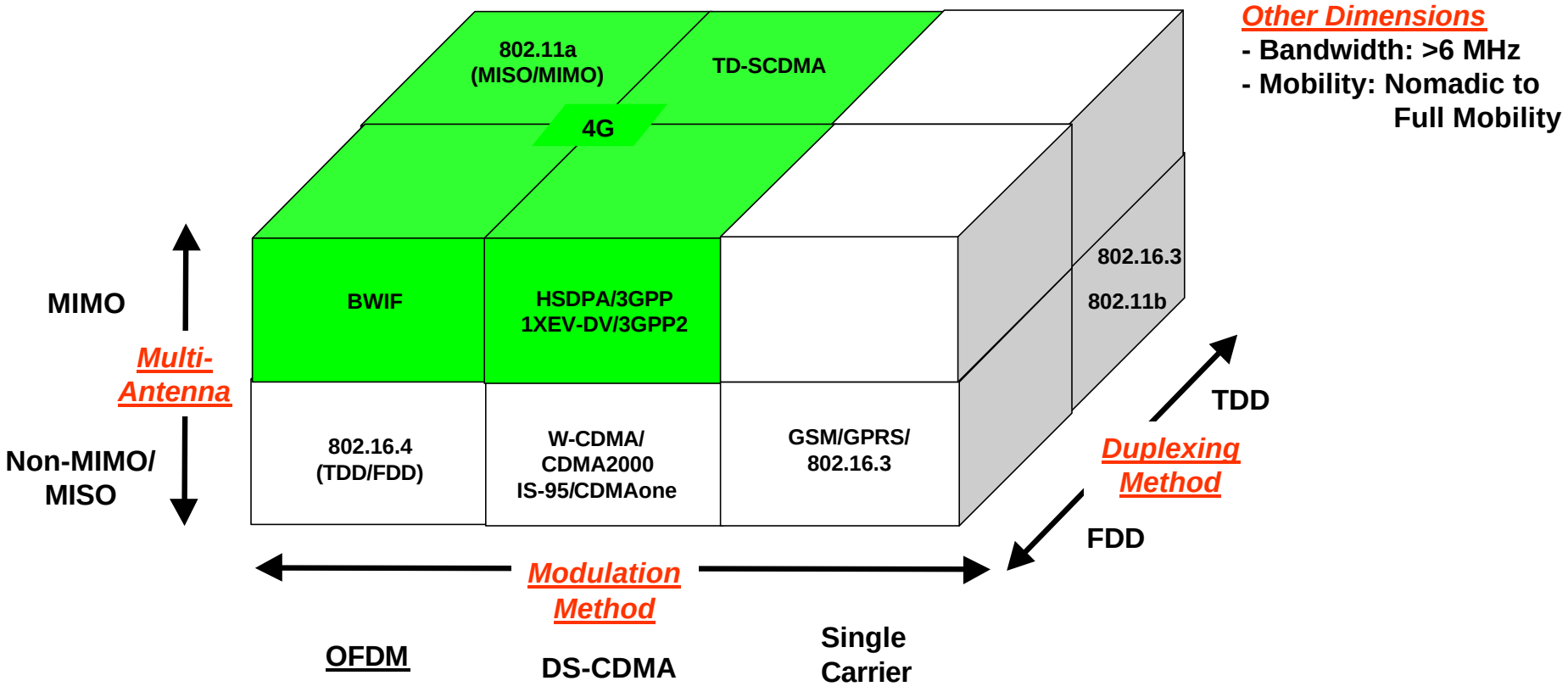
Roadmap to 4G Wireless



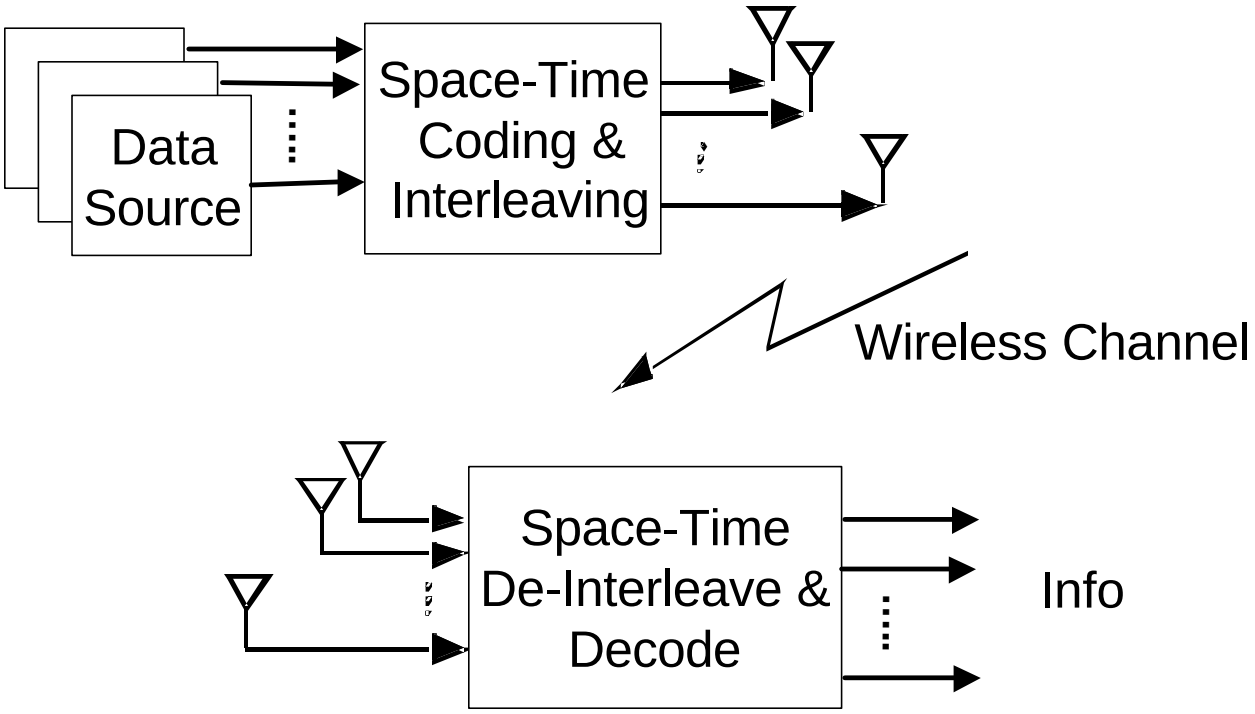
Physical Layer for 4G



Important 4G Technology Components

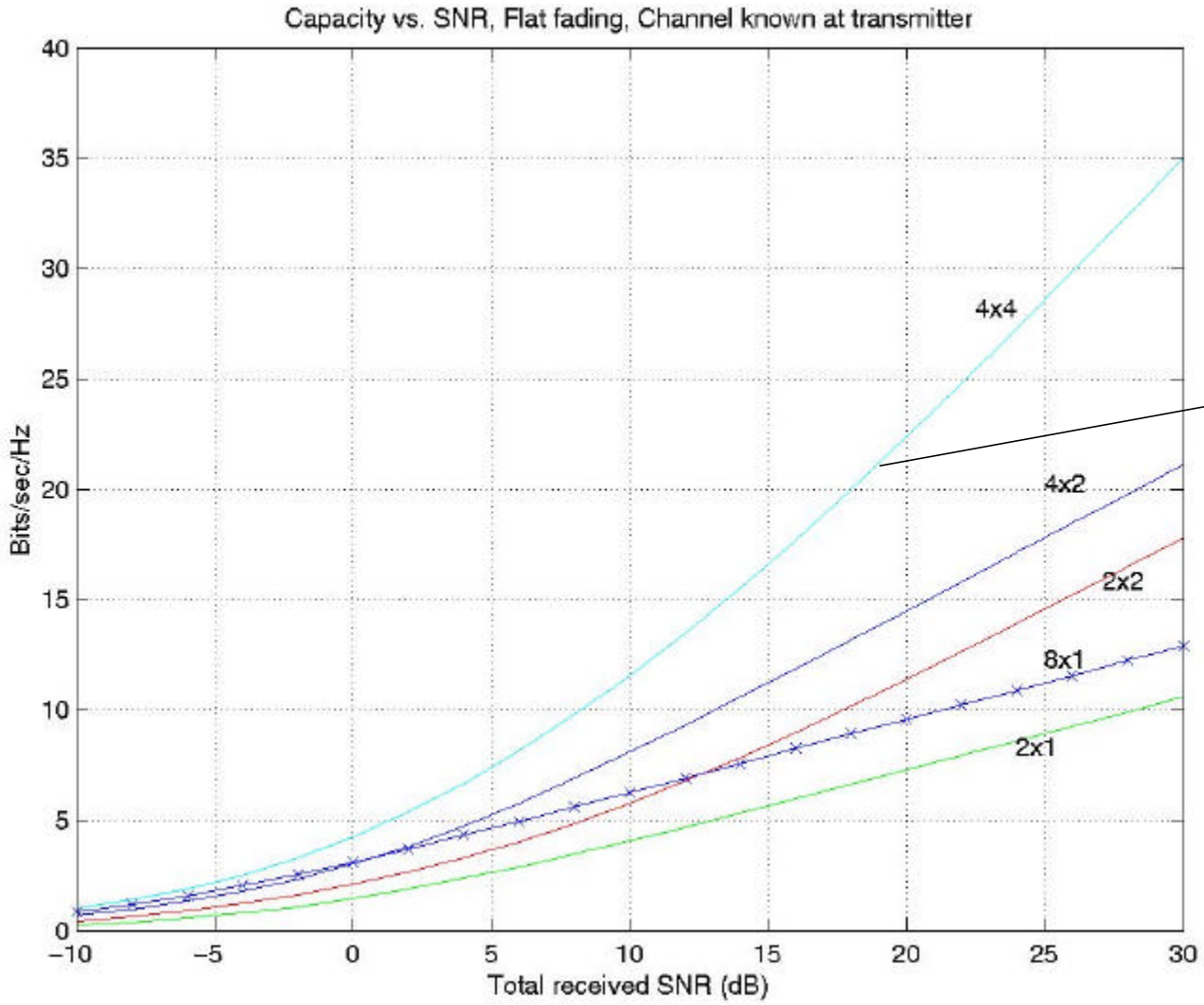
- **Space-Time Coding and MIMO**
  - Spatial diversity and coding gains for large link budget gains (>10 dB)
  - Only minimal use in today's systems
  - Complexity vs. performance trade-off
- **Beamforming**
  - Range increase, link budget increase
  - Space-division multiplexing
  - Smart antenna gains for class of single-antenna receivers
- **Other techniques to achieve higher capacity**
  - Frequency / Code / Time Diversity
  - Interference Cancellation / Multi-user detection (MUD)
  - Exploit multipath diversity (OFDM / CDMA)
  - LDPC codes for best performance at low complexity
  - Fast ARQ for robust, low delay data transmission

Space-Time Coding for MIMO Systems



- *Increases data rates due to multiple transmit and receive antennas*
- *Combats fading*
- *Increases basestation-to-user capacity*
- *Cost is scalable with performance*

MIMO Advantages



4x4 MIMO

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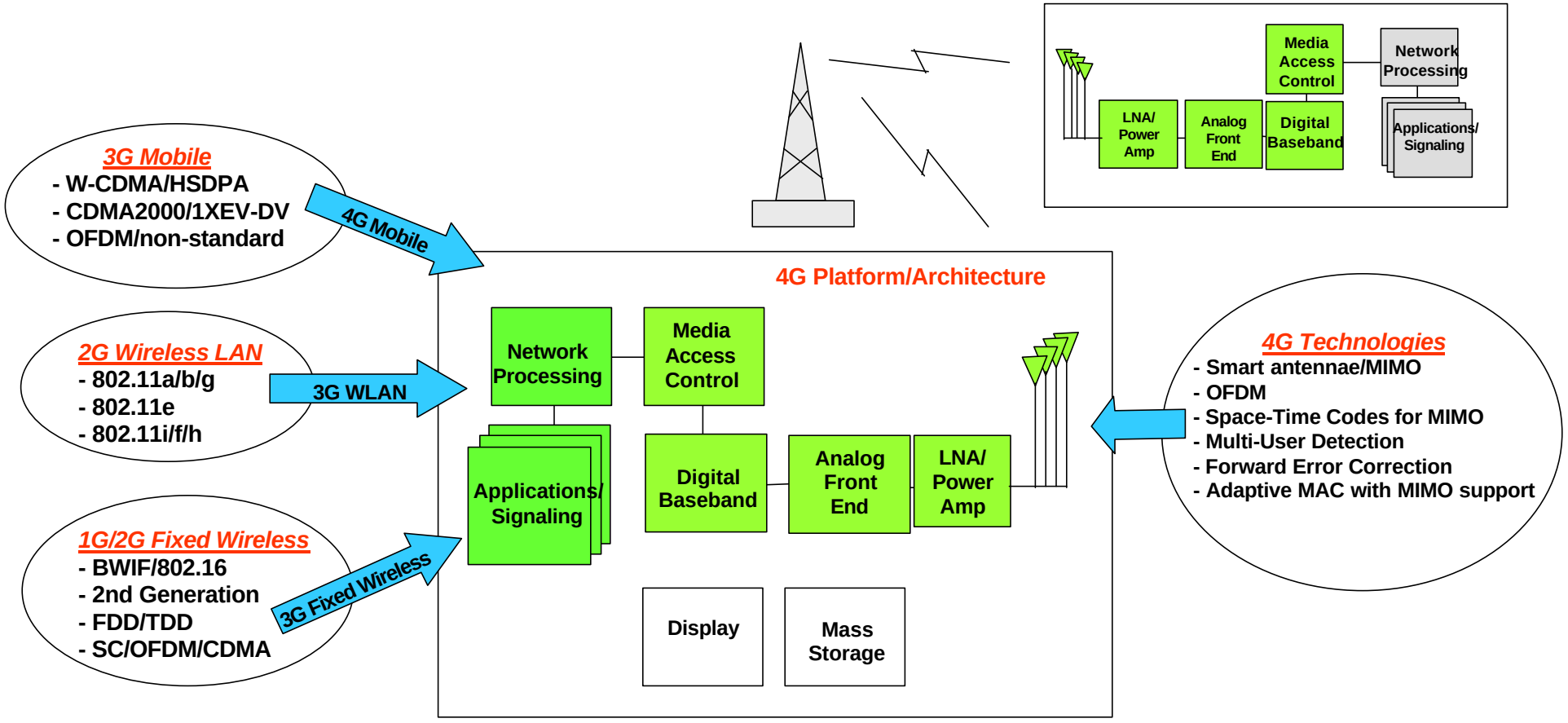
Broadband Communications Platforms



Emerging Implementations -- Massive Integration

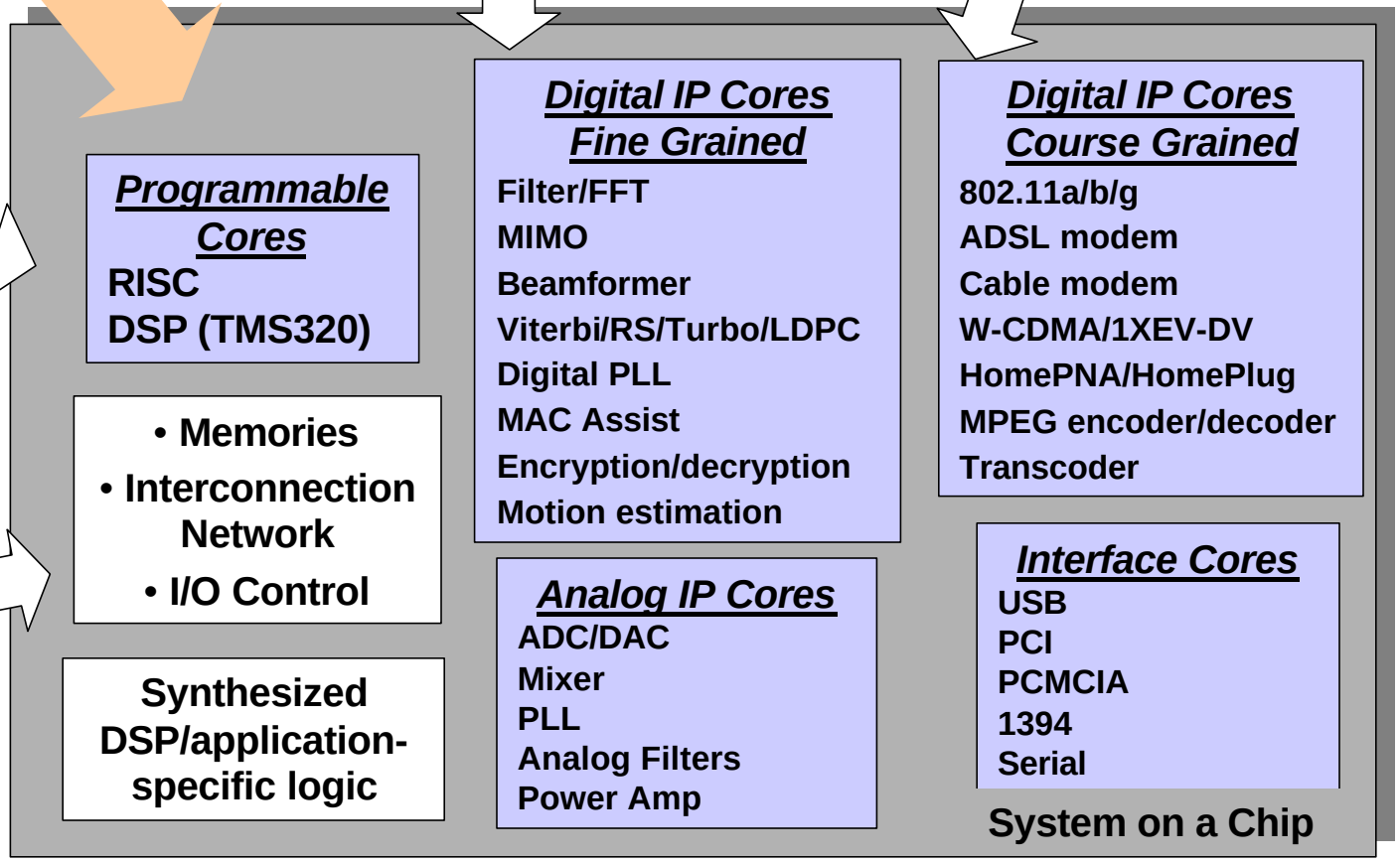
Systems Engineering
- Cost/size/power/performance
- HW/SW Partitioning
- Algorithm development
- Standards

Intellectual Property
- Algorithms
- Architectures
- Core Designs

Design Methodology
- Datapath/Control
- Co-development (HW/SW)
- Uniform design flow for re-usability

Software
- *DSP algorithms*
- *Compilers*
- *Device drivers*
- *RTOS*
- *Debug tools*

Diagnostics/Testability
- *Analog front end performance*
- *Algorithm/IP core performance*
- *Digital diagnostics*
- *Interoperability*
- *Co-existence/ compatibility*



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Summary

- ***On-chip functionality is increasing rapidly***
  - Digital / analog integration
  - Software, analog, protocol stacks, system interfaces, applications
  - >> 100 Kgates per sq. mm.
- ***Recovering non-recurring engineering/R&D expense***
  - Requires increased hardware and software re-use
- ***Programmable DSP will drive the broadband communications market coupled with re-usable application-specific IP blocks***