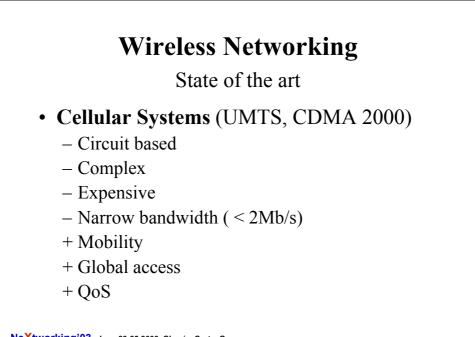
# Wireless Networking

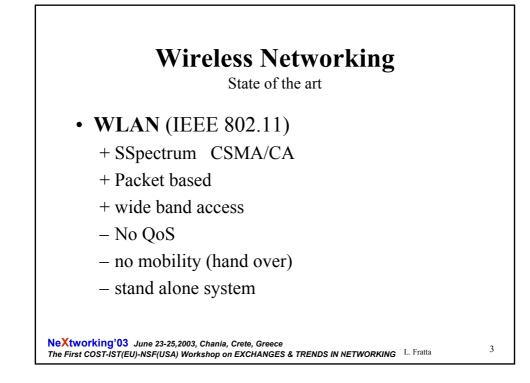
#### Driving forces & Research issues

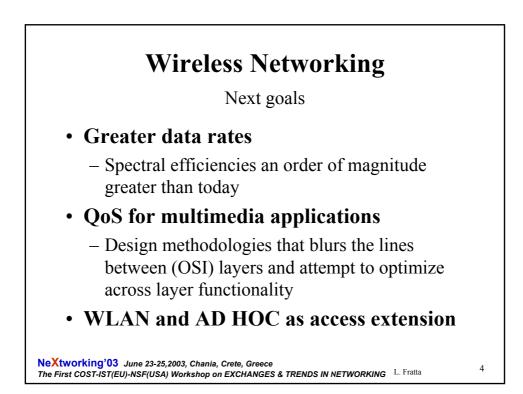
- Wireless technology landscape
- Driving forces for technological advances
- New or existing spectrum allocation to be readily adopted
- Access to capital
- Internet
- Widespread demand for always-on access to data

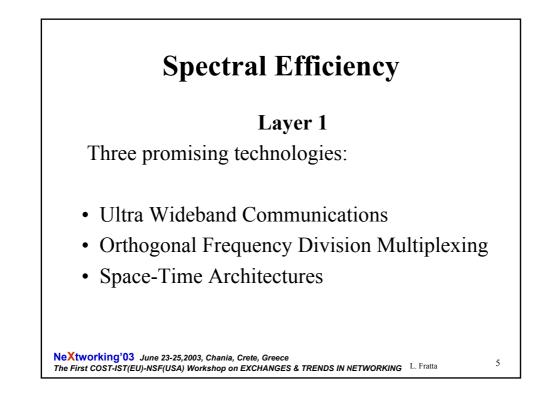
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#### **Ultra Wideband Communications UWB** • Approved by FCC for communications and sensing applications • Ultra short baseband pulses with a bandwidth of several GHz • No radio frequency up conversion: a base band transmission that propagates at RF frequencies • Can simultaneously coexist with existing RF devices throughout the spectrum • Extremely low power spectral density • Reliable data rates exceeding 100Mb/s within buildings Extremely low-cost wideband transmitter devices NeXtworking'03 June 23-25,2003, Chania, Crete, Greece 6 The First COST-IST(EU)-NSF(USA) Workshop on EXCHANGES & TRENDS IN NETWORKING L. Fratta

### Orthogonal Frequency Division Multiplexing OFDM

Based on an Old concept today attractive due to recent advances in highspeed and powerful VLSI

Unique features:

- · Robust against multipath fading and inter-symbol interference
- Adaptive modulation and power allocation across sub-carriers
- Robust against narrowband interference
- Single frequency networks
- Adopted in IEEE 802.11
- Candidate for fourth-generation broadband multimedia wireless communication systems

Open issues

- Large peak-to- average power ratio which reduces power efficiency in RF amplifier
- Susceptible to frequency offset and phase noise

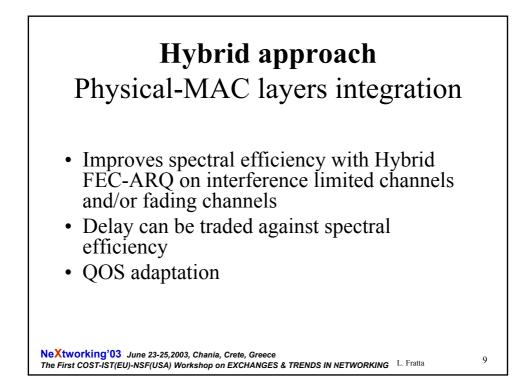
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## **Space-Time Architectures**

- Space-time processing technology and multiple-input-multiple-output (MIMO) antenna architectures exploiting small-scale temporal and spatial diversity with antennas and error-control codes vastly improves spectrum efficiency
- May be used in both cellular and ad-hoc network architectures
- Smart antennas effective
  - in range improvement (cellular systems)
  - in throughput increase due to suppression of co-channel interference (CELL SYS & WLAN)
- Diversity obtained by temporal, frequency, spatial and polarization spacings mitigates deep fadings
- · Small complexity to increase spectrum efficiency
- · Significant gains in
  - Energy efficiency
  - Spectral efficiency

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# New Network Design methodologies (1/3)

#### Past/Present

#### Layered OSI design methodology

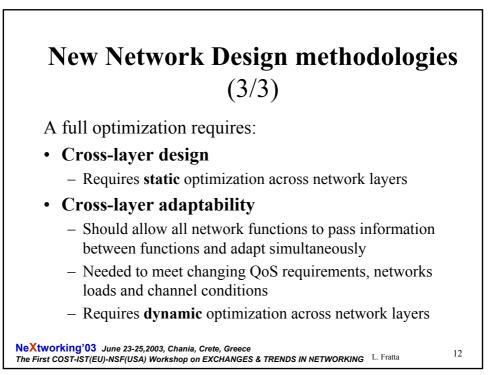
- Physical Layer: modulation, power control, data rate, spreading
- Data Layer Link: frame size, FEC, ARQ, power control, radio resources control, multiple access
- Network Layer: routing, congestion control, packet size, QoS

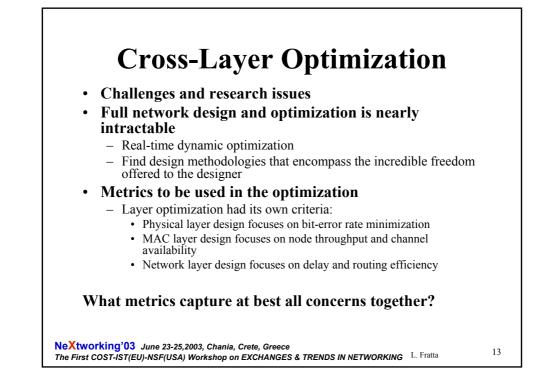
#### Emerging wireless networks must support:

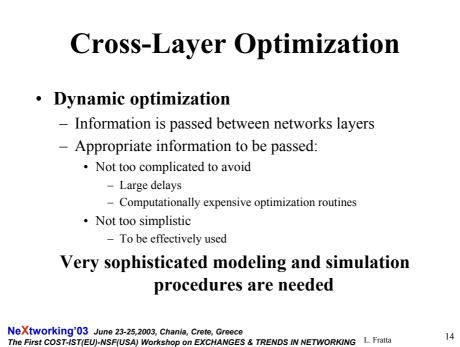
- Various and changing traffic types with their associated QoS
  - Multi media traffic with manifold delay, error-rate and bandwidth requirements
- · Changing topologies
  - Continuously entering and leaving nodes
  - Radio link failures
  - Lack of network infrastructure (ad hoc nets)

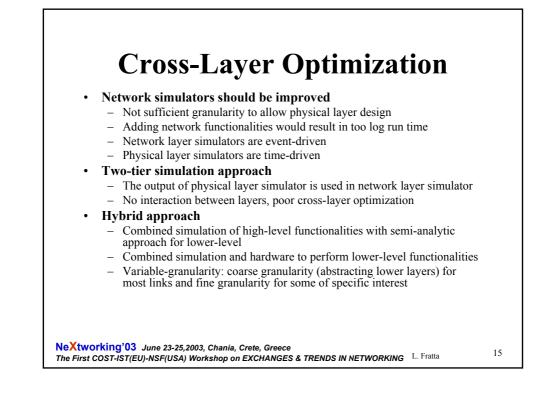
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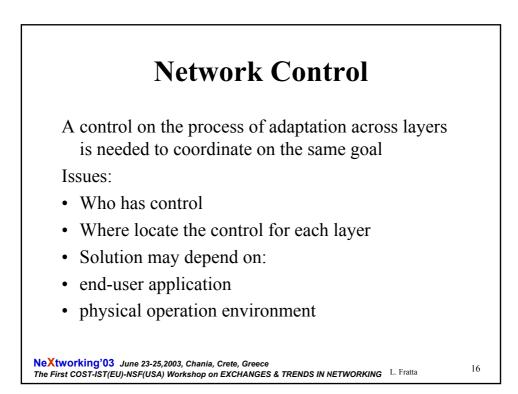
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# WLAN and AD HOC as access extension

- Different 802.11 WLANs coexistence is inefficient
- Frequency reuse must be increased
- AD HOC operation can extend access range
- QOS must be provided for multimedia traffic
- Roaming and hand-over must be provided

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Further Key Research Themes
Cheaper more ubiquitous radios
Improved performance

IEEE 802.11 11 → 54 → 200+
Adaptive modulation schemes
Smart antennas
Adaptive MAC

New radio approaches

UWB
OFDM
Space-Time Processing
Ad-Hoc Networks

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# **Further Key Research Themes**

- Flexibility
  - Multiple standards
  - Multiple services
  - New regulatory approaches

#### • Competition / Integration of various radio systems

- LAN/WAN roaming
- Vertical Handover
- Multi standard embedded systems (BT, 802.11, GPRS)
- VoIP over 802.11 (cell system competitor)

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