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School of Science
and Technology

Value Network Design for Internet

COST605 PhD Workshop

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Team Intro: Research Topics and Methods

Research topics (substance)

- Networks (investments)
  - Wide and local area radio access
  - Internet architecture evolution
  - Value networks (MNO, MVNO, ISP,..)
- Services
  - Service adoption and diffusion
    - User behavior, context, usage
  - Regulation
    - Roaming
    - Bundling of device, access, service/content

Research methods (toolbox)

- Qualitative methods
  - Industry scenario construction
  - Business simulation (games)
  - Expert interviews
- Quantitative methods
  - Usage data collection/statistics
  - Consumer surveys
  - Techno-economic/business case modeling
  - System dynamics
  - Functional/mathematical modeling

Theories (frameworks)

- Porter's five forces
- Network effects
- Long tail
- Prospect theory/flat-rate preference
- Two-sided markets
- Utility theory / value of time
- Real options theory
- Game theory

What is a Value Network?

- "A **value network** is a business analysis perspective that describes social and technical resources within and between businesses. The nodes in a value network represent people (or roles). The nodes are connected by interactions that represent tangible and intangible deliverables. These deliverables take the form of knowledge or other intangibles and/or financial value. Value networks exhibit interdependence. They account for the overall worth of products and services. Companies have both internal and external value networks." (Wikipedia)

What is a Value Network?

- “The collection of upstream suppliers, downstream channels to market, and ancillary providers that support a common business model within an industry. When would-be disruptors enter into existing value networks, they must adapt their business models to conform to the value network and therefore fail that disruption because they become co-opted.” (Clayton Christensen)
- And many other definitions…

Value Network and Related Concepts

- Value Chain is the linear case of value network (cmp. supply chain, demand chain)
- Industry Structure and Sector Structure refer to slowly changing value networks with high value to society
- Market Architecture refers to value networks having an architect; modifiable but of high value

Who Designs Value Networks?

- Law maker typically interested in established infrastructure industries having monopolistic tendency
- Large firms having the market power to create and maintain self-centered value networks (and ecosystems)
- Standardization organizations working on system level technologies (cmp. 3GPP and IETF)
- Start-up firms trying to disrupt the established value networks with novels ones

Technical vs. Market Architecture

What is the linkage?

	Technical architecture	Market architecture
Interacting nodes	Computional nodes	Legal persons
Interaction spec	Software protocol	Legal contract/SLA
Transactions	Computational	Financial
Architect	Engineer	Economist/lawyer

- Software is code (Lessig)
- Technical may define the market architecture, and vice versa
- Linkage of technical and market architectures gets stronger due to
  - more flexible ICT systems (trend toward more complex systsms)
  - spreading of Internet connectivity in products (Internet of Things)
  - faster increase of bit share (cmp. atom share) in services

Standardization and Market Architecture

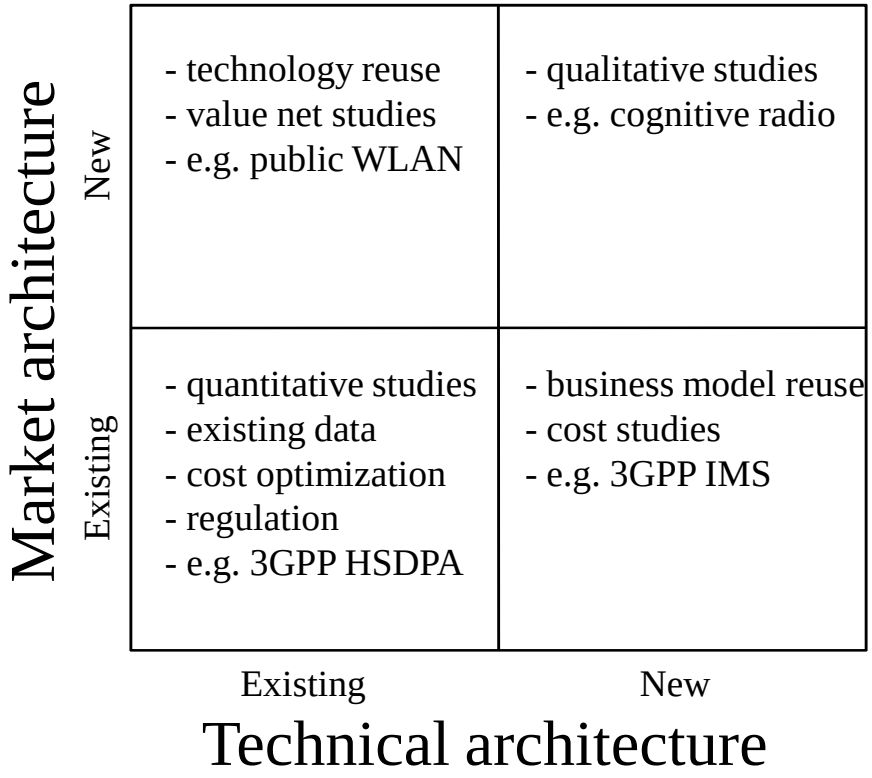
Case: 3GPP vs. IETF

	3GPP	IETF
Standardization output	System specs	Protocol specs
Approach	Top-down	Bottom-up
Driving actors	Big firms	Individuals
Market architecture assumption	Vertical	Horizontal
Structural evolution	Planned	Market-driven

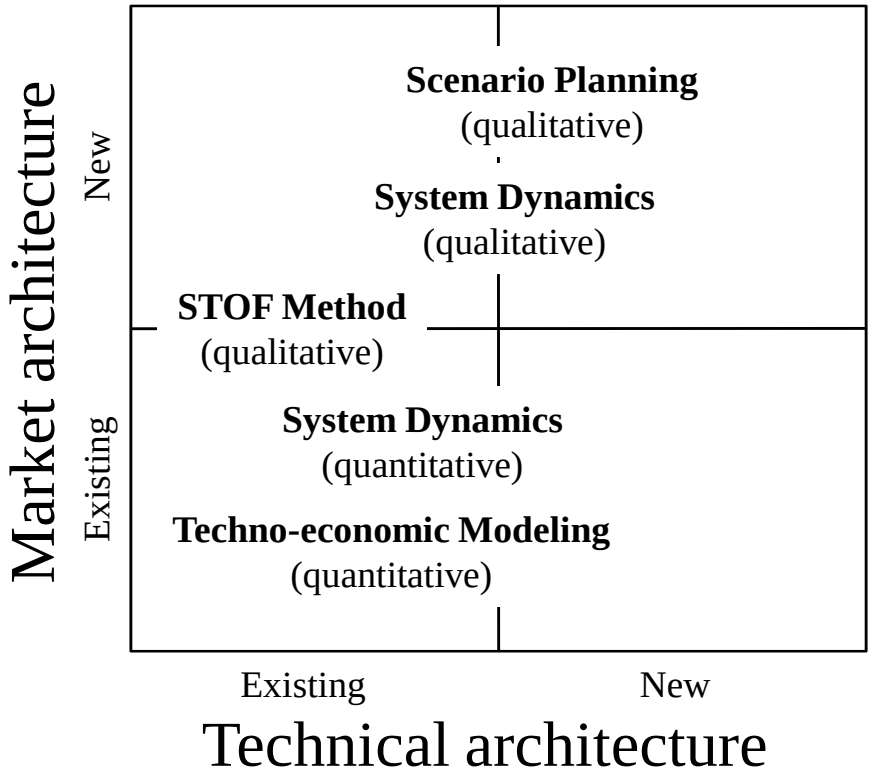
- 3GPP drives the technical+market architecture (IETF not)
- Which approach can handle big technology steps better?

Structural Renewal and Research Scope

Forward-looking Thinking



Research Methods on Structural Renewal



- Comparison of technologies, technical architectures, or market architectures?
- Possible viewpoints: single firm, role, group of firms, consumer, society

List of Example Cases

- **Scenario planning**: Future Internet architecture
- **System dynamic modeling**: Indoor radio
- **Techno-economic modeling**: fixed WiMAX
- **Business model design/STOF**

Scenario Planning Method

Case: Future Internet Architecture

- This case
  - Performed in 2009
  - Part of national Tivit/Future Internet program
- Other scenario planning cases
  - Local radio access
  - Home networks
  - Mobile peer-to-peer services
  - Mobile voice over IP

Research Question of Scenario Planning

Case: Future Internet

- Which are the alternative (technological) scenarios for Internet over 10 years and what are the key trends and uncertainties that produce these scenarios?

Supporting Strategic Question

- IETF standards: What should be the IETF strategy of TIVIT/Future Internet Programme to cope with each scenario?

Source: Tapio Levä, 2009

Scenario Planning Process

1. Setting the scene and scope

- Define *time frame*, *scope* and *decision variables.* Identify major *stakeholders.*

2. Identifying key trends and uncertainties

- *Key trends* = important forces whose consequences have not yet unfolded.
- *Key uncertainties* = important forces whose outcomes are not very predictable.

3. Scenario construction

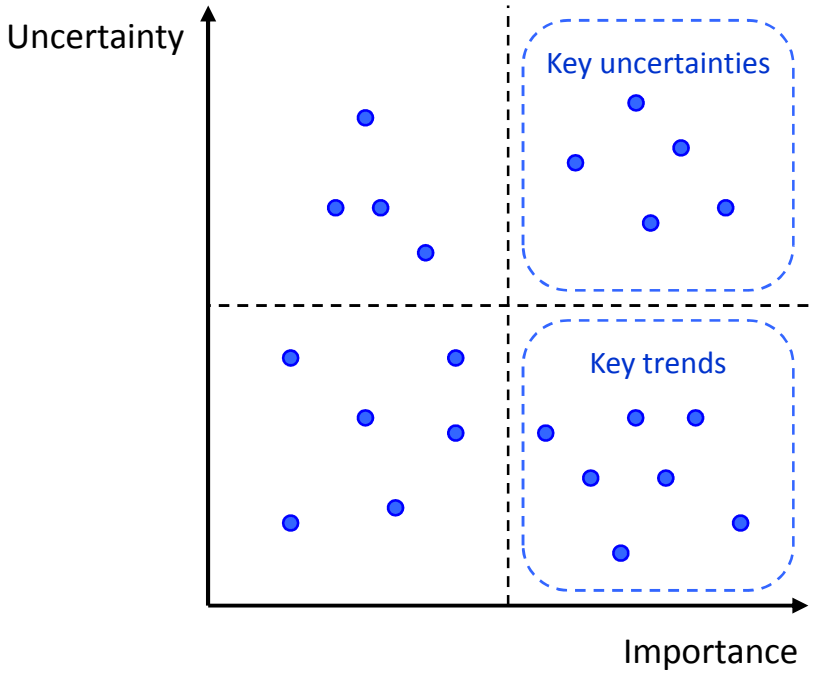
- *Select two most important key uncertainties* → scenario matrix.
- Add impact of other key uncertainties and trends.
- Assess *internal consistency* and plausibility, revise.
- Assess *stakeholder behaviour.*

4. Quantitative modelling

Source: Schoemaker, 1993, Tapio Levä, 2009

Identifying Key Trends and Uncertainties

- Brainstorming
  - To identify key trends and uncertainties
  - 3 sessions with academics and industry experts
  - Divided to 4 x 45 min
    - **P**olitical / regulatory forces
    - **E**conomic / industry forces
    - **S**ocial forces
    - **T**echnological forces

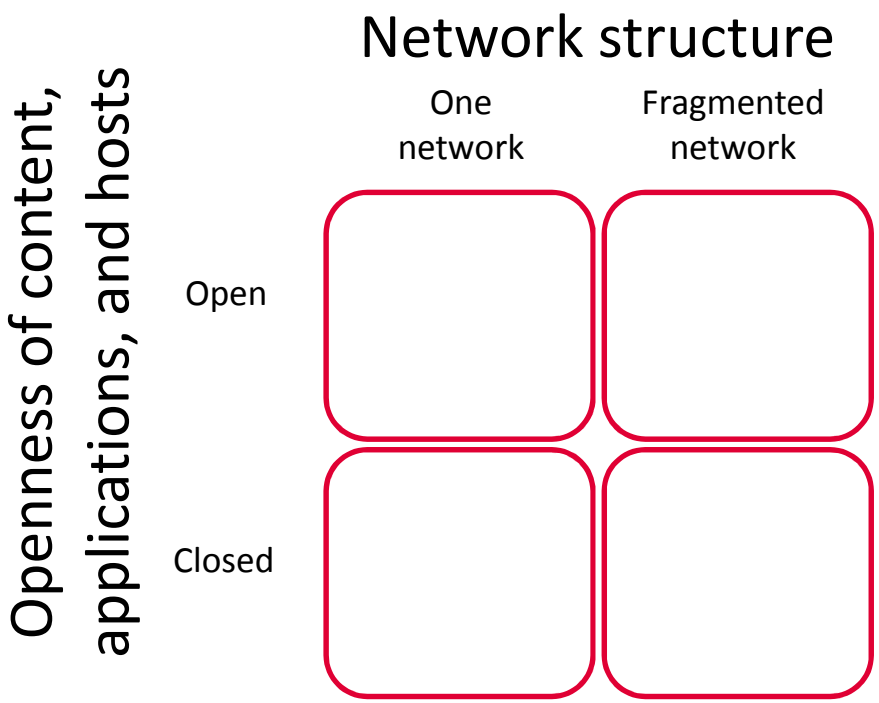


- Expert interviews
  - To deepen the understanding of key uncertainties and scenario drafts
  - 11 interviewees representing different stakeholders

Source: Tapio Levä, 2009

Key Uncertainties

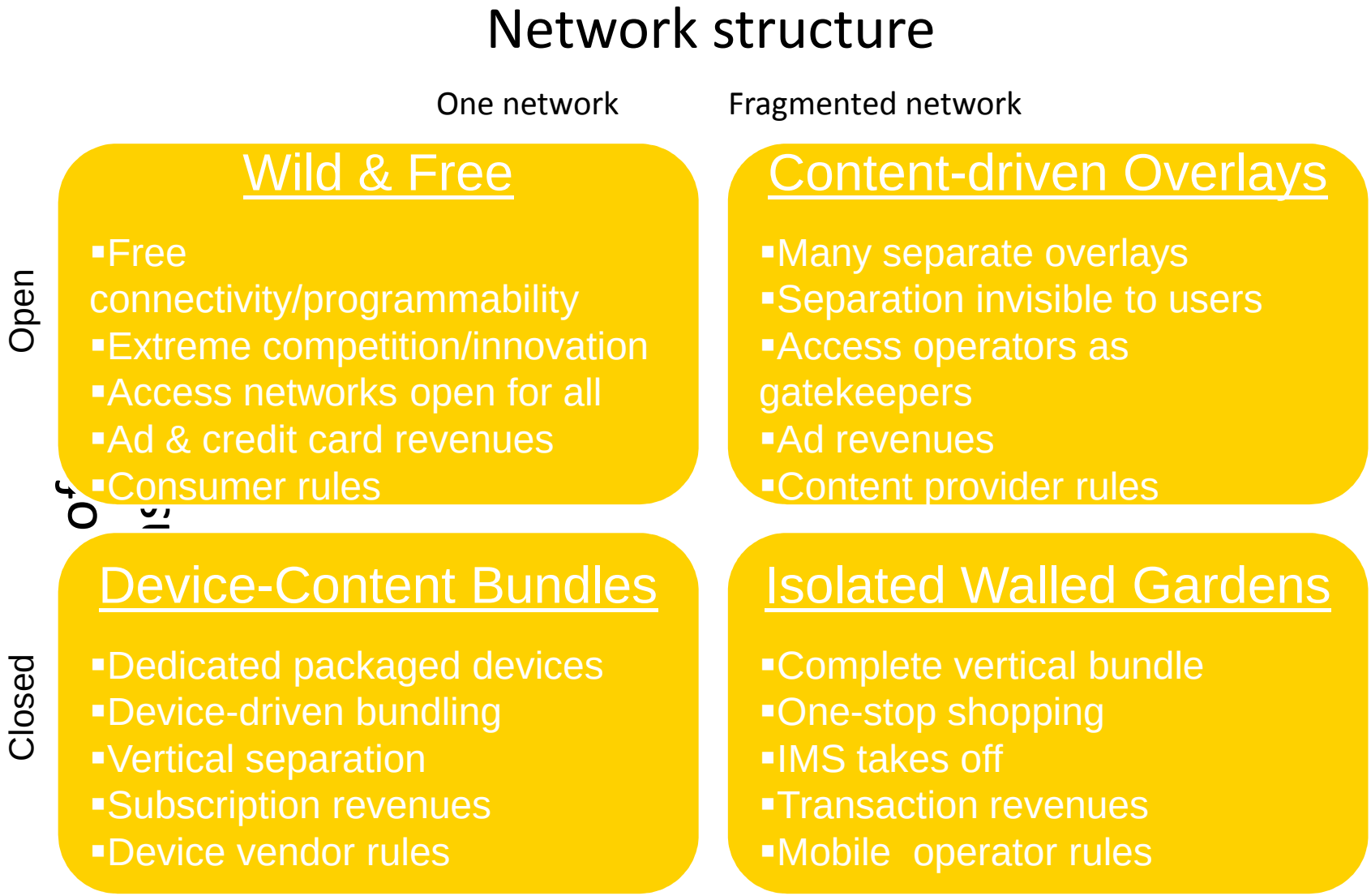
- Most important key uncertainties
  - Network structure?
  - Openness of content, applications, and hosts?



- Other key uncertainties
  - Will Internet face a larger collapse?
  - Where will the intelligence be located?
  - What will be the dominating business model in Internet economy?
  - Where will the standardization happen?
  - What is the level of trust / security / authentication in the Internet?
  - Will the traffic be treated neutral?
  - Standards vs. proprietary solutions?

Source: Tapio Levä, 2009

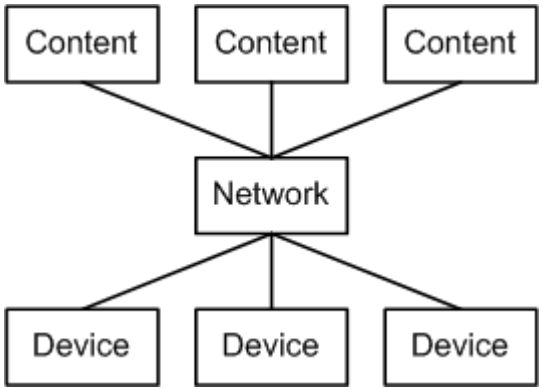
Internet Architecture Scenarios



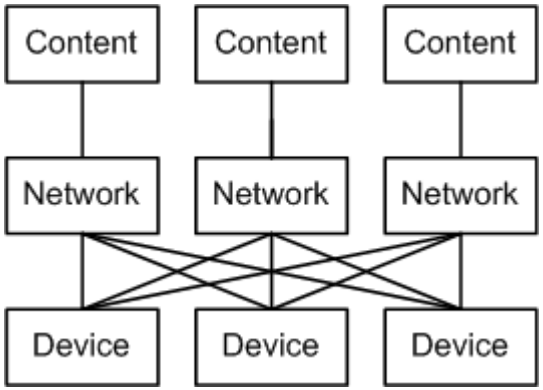
Source: Tapio Levä, 2009

Tech+Industry Architecture in Scenarios

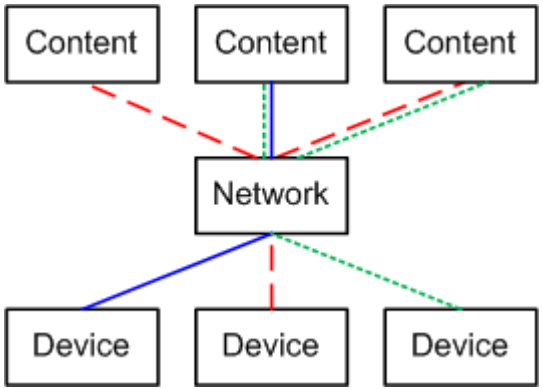
Wild & Free



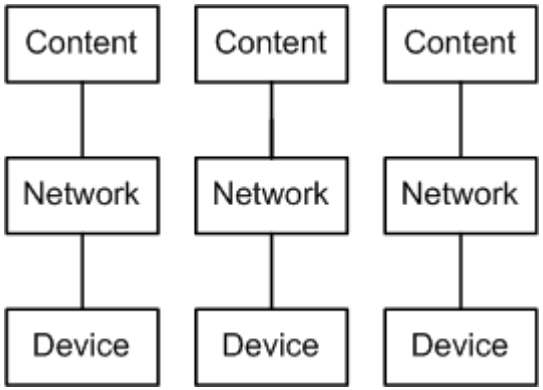
Content-driven Overlays



Device-Content Bundles



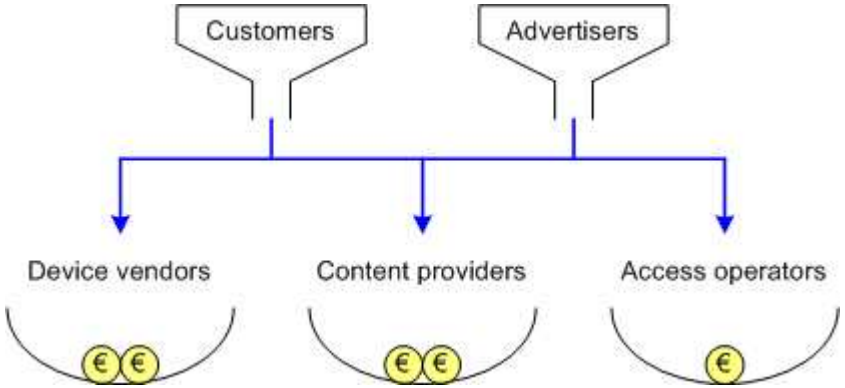
Isolated Walled Gardens



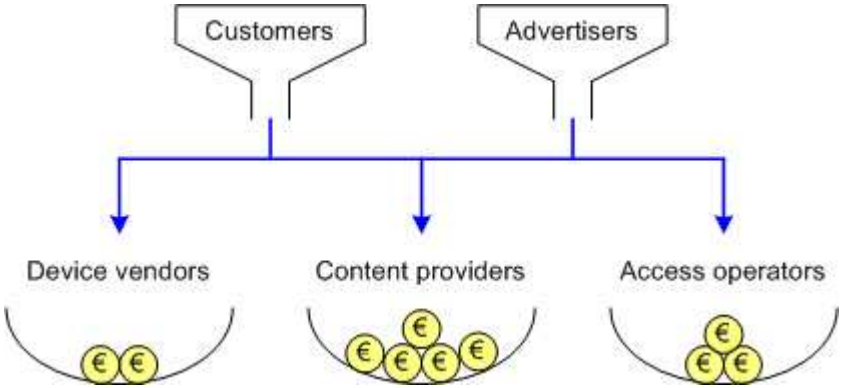
Source: Tapio Levä, 2009

Value Distribution in Scenarios

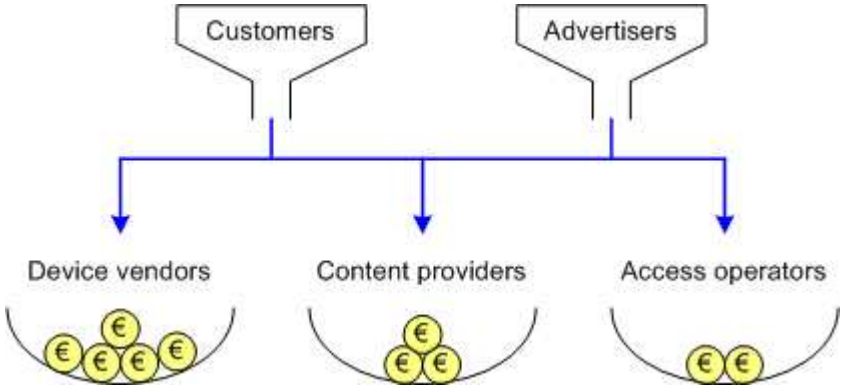
Wild & Free



Content-driven Overlays



Device-Content Bundles



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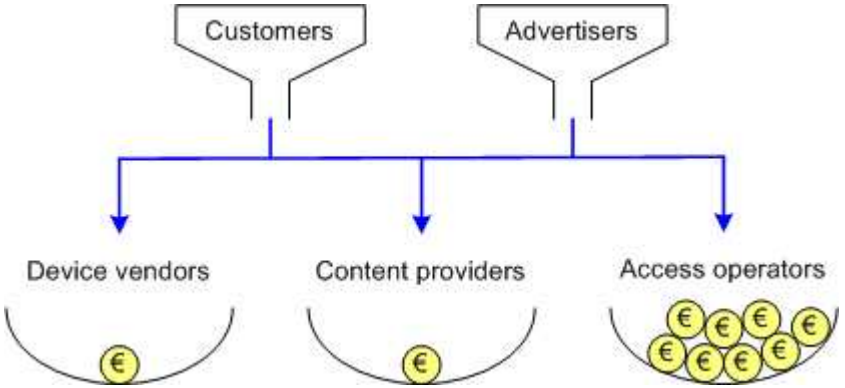

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Source: Tapio Levä, 2009

System Dynamic (SD) Modeling
Case: Wireless Local Area Networks

- This case
  - Performed in 2009
  - Part of Aalto University/IMCOS project

- Other system dynamic modeling cases
  - Peer-to-peer networking
  - Mobile handset bundling
  - Internet core protocols diffusion

System Dynamic Modeling
Typical Research Process

- Research process at Aalto University
  1. Scenario planning (Schoemaker, 1993)
  2. System dynamic modeling (J. Sterman, 2000)
- Research process at MIT

  (When using the Value Chain Dynamics Toolkit, prof. Fine)
  1. Sketch, Deconstruct, Transactions, Architecture
  2. Control points
  3. Control point constellations
  4. Business models, triggers
  5. System dynamic modeling (qualitative vs. quantitative)

Case Description

Research question

- How will the Internet connectivity to indoor located devices provided in the future?
- What are the possible evolution paths?
- Time Frame: 2009-2015

Scope

- Battle between indoor and outdoor radio (IEEE/WLAN vs. 3GPP/LTE)
- Focus on mobile and laptop devices
- Focus on the Finnish market

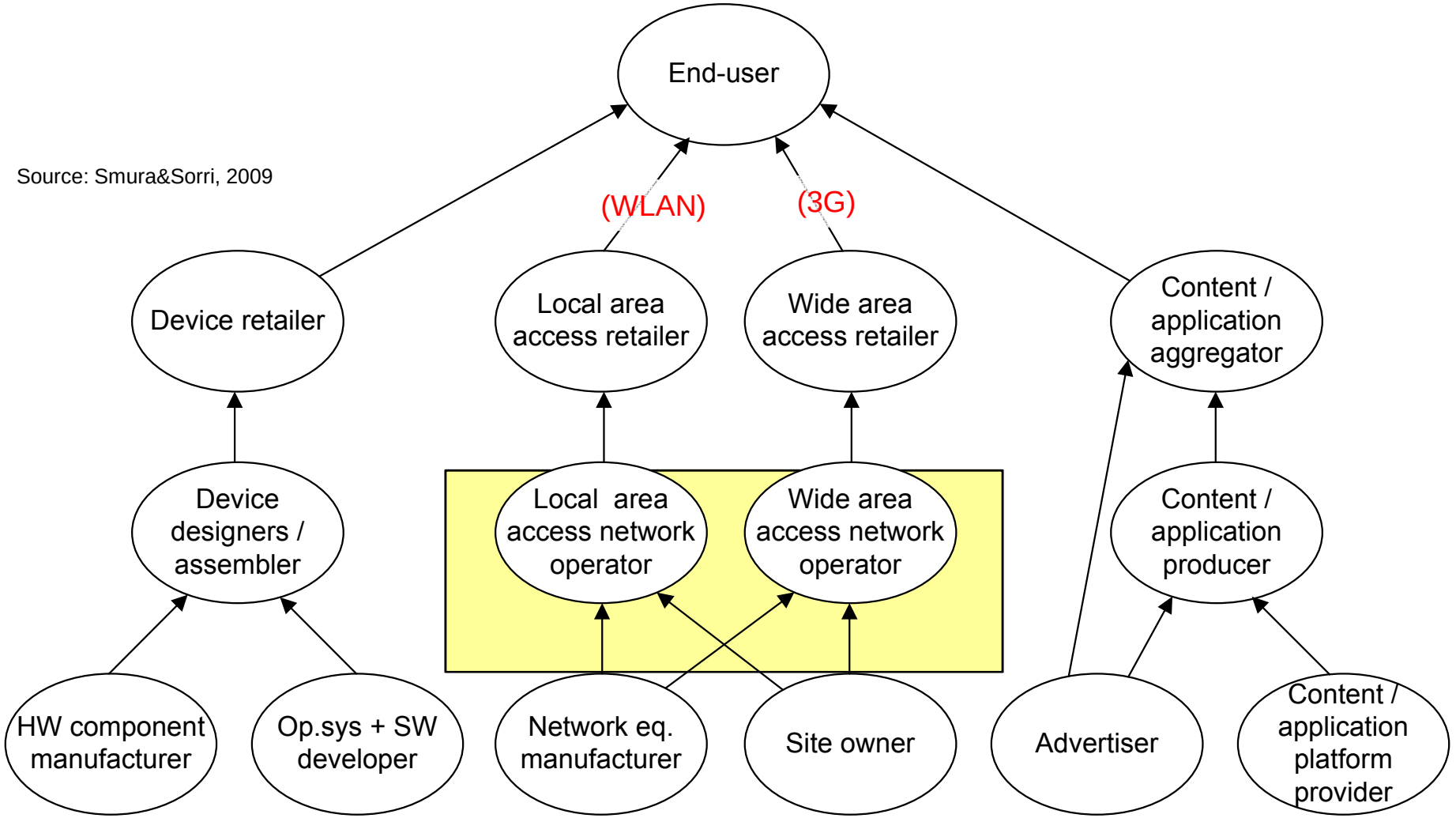
The overall goal is to understand dynamic relationships between forces, not to model exact numerical values

Source: Abebe&Casey, 2009

Mobile Services Value Network

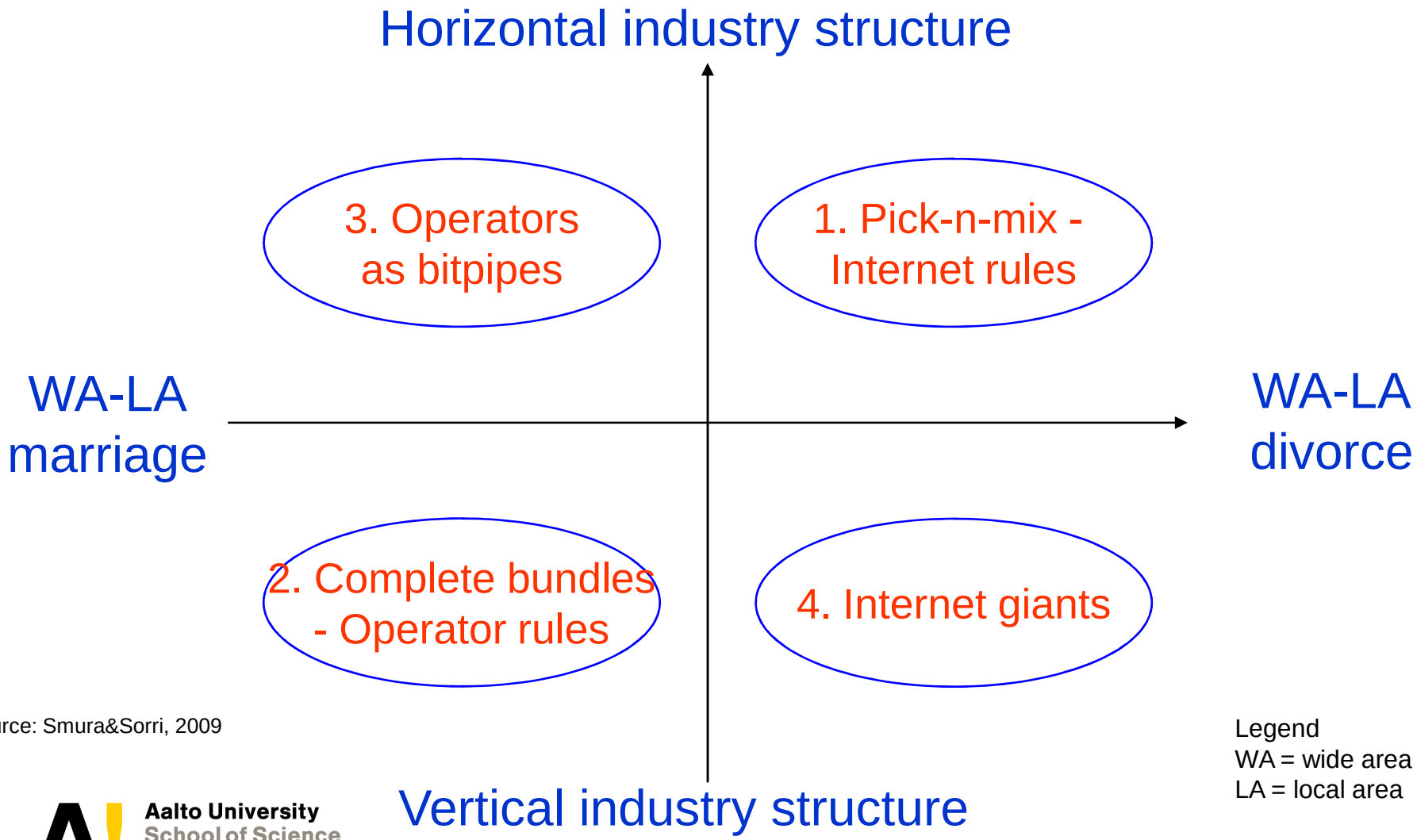
Access Battle between Local and Wide Area

Source: Smura&Sorri, 2009



Radio Access Scenarios

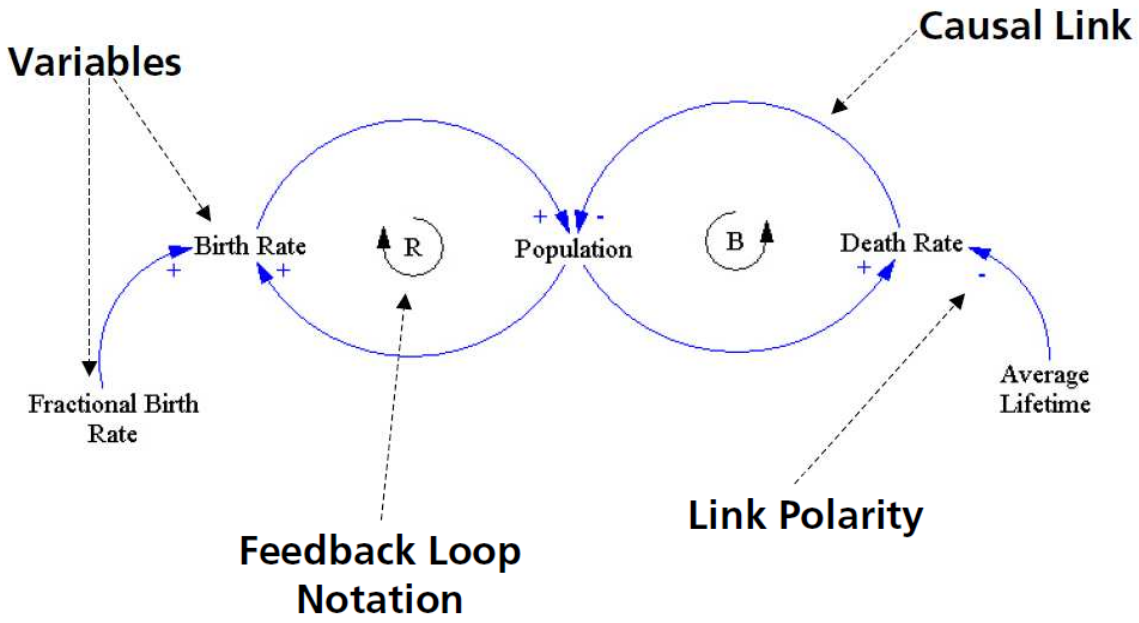
Four possible scenarios placed in a matrix



Source: Smura&Sorri, 2009

Legend
WA = wide area
LA = local area

Basics of System Dynamics



Causal loops diagrams (feedback loops)

R = re-inforcing loop

B = balancing loop

Main Forces Picked Up for SD Modeling

Uncertainties

U1: Industry structure

U2: Competition between technology substitutes

U3: Spectrum policy and regulation

U4: Role of unlicensed spectrum

U5: Number of connected devices

U6: Role of emerging markets in affecting technology choices

Trends

T1: Devices' capabilities and performance improve

T2: Wireless traffic will increase

T3: Number of base stations / access points increases

T4: Importance of indoor wireless access increases

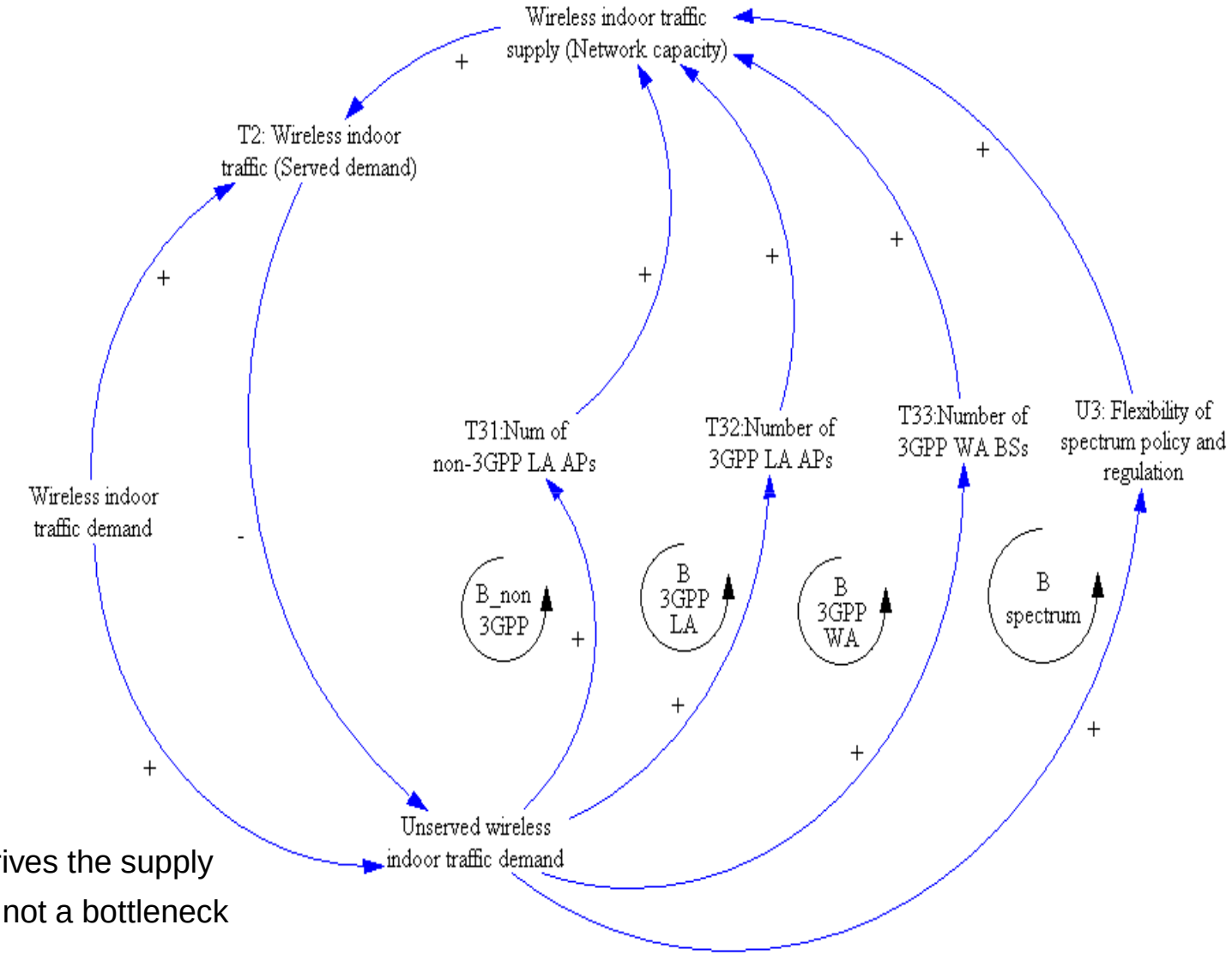
T5: Role of developing countries increasing

T6: Operational costs will dominate over hardware costs

T7: Wireless emissions scare people

Source: Smura & Sorri (2009)

Conceptual SD Model



Assumptions

- Unserved demand drives the supply
- Backhaul capacity is not a bottleneck

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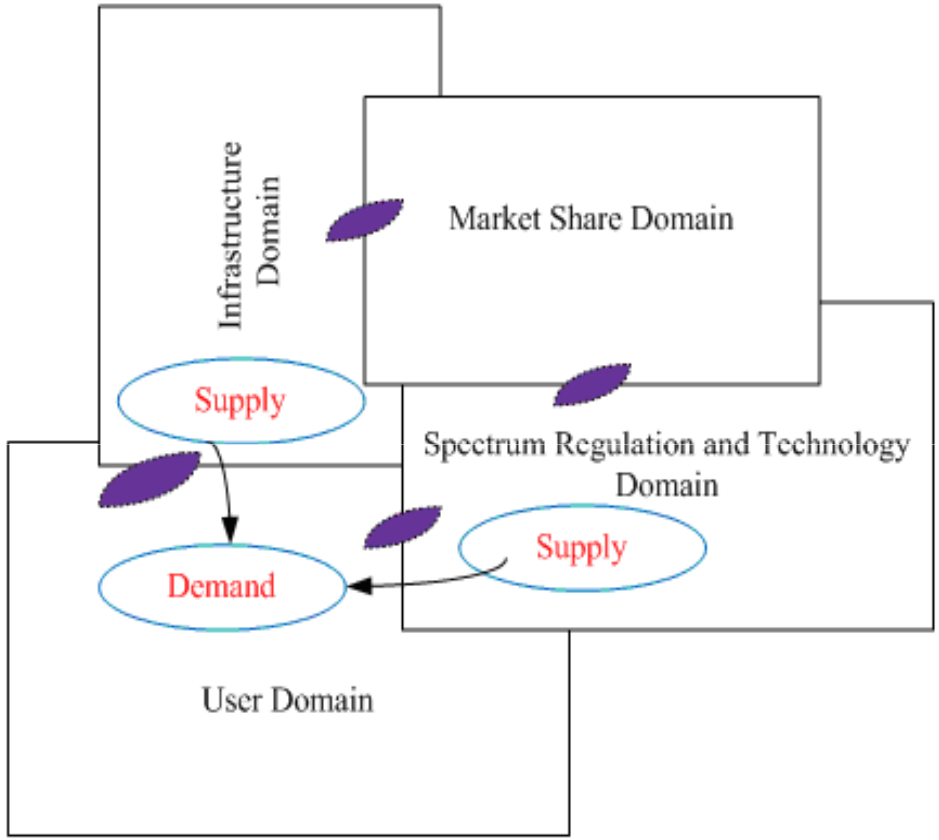
Source: Abebe&Casey, 2009

How to Handle Complexity?

Top-down vs. Bottom-Up

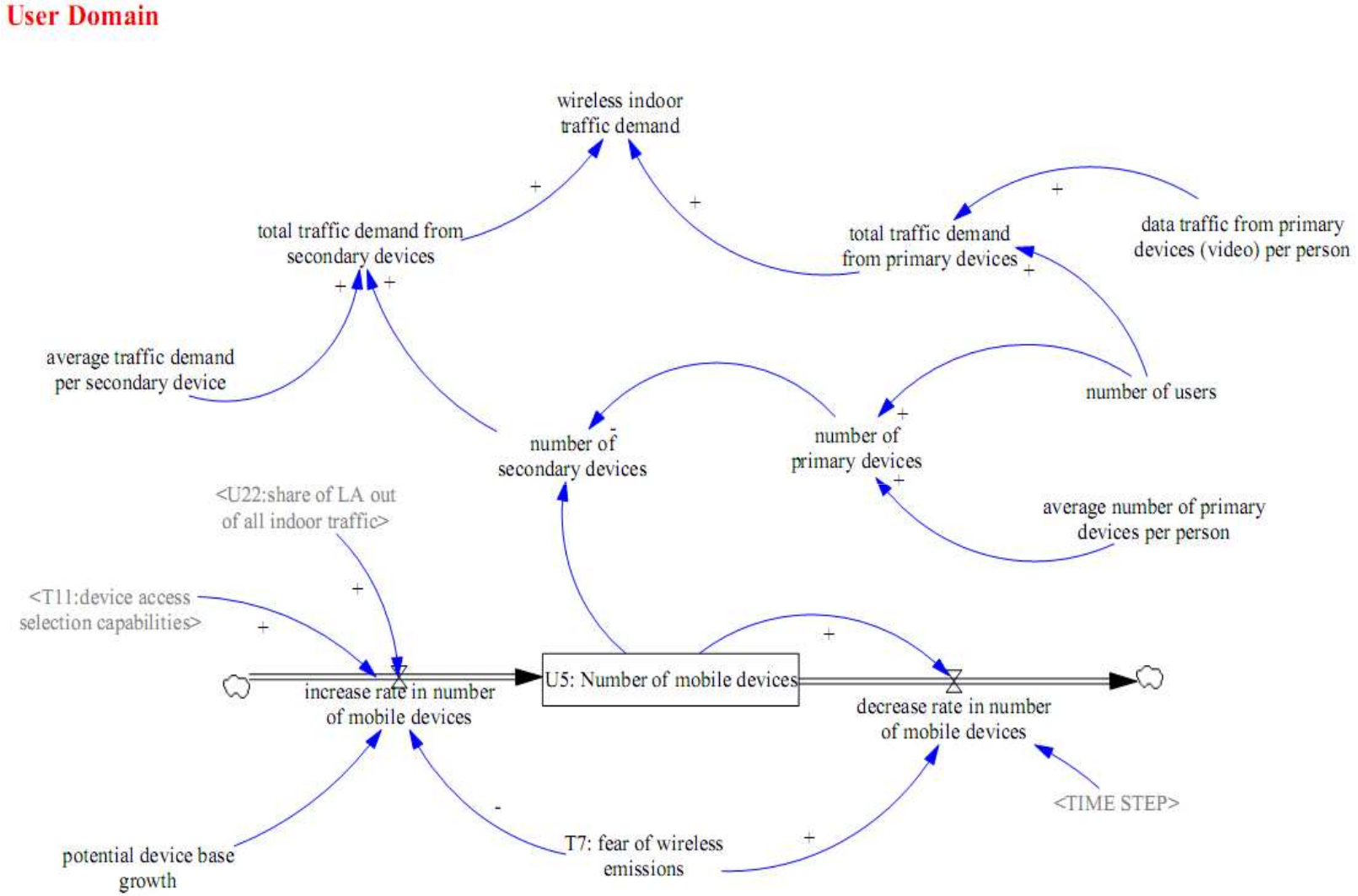
The model is split in four domains

1. User (Demand)
2. Infrastructure (Supply)
3. Spectrum Regulation and Technology
4. Market Share (in terms of traffic volume)



Source: Abebe&Casey, 2009

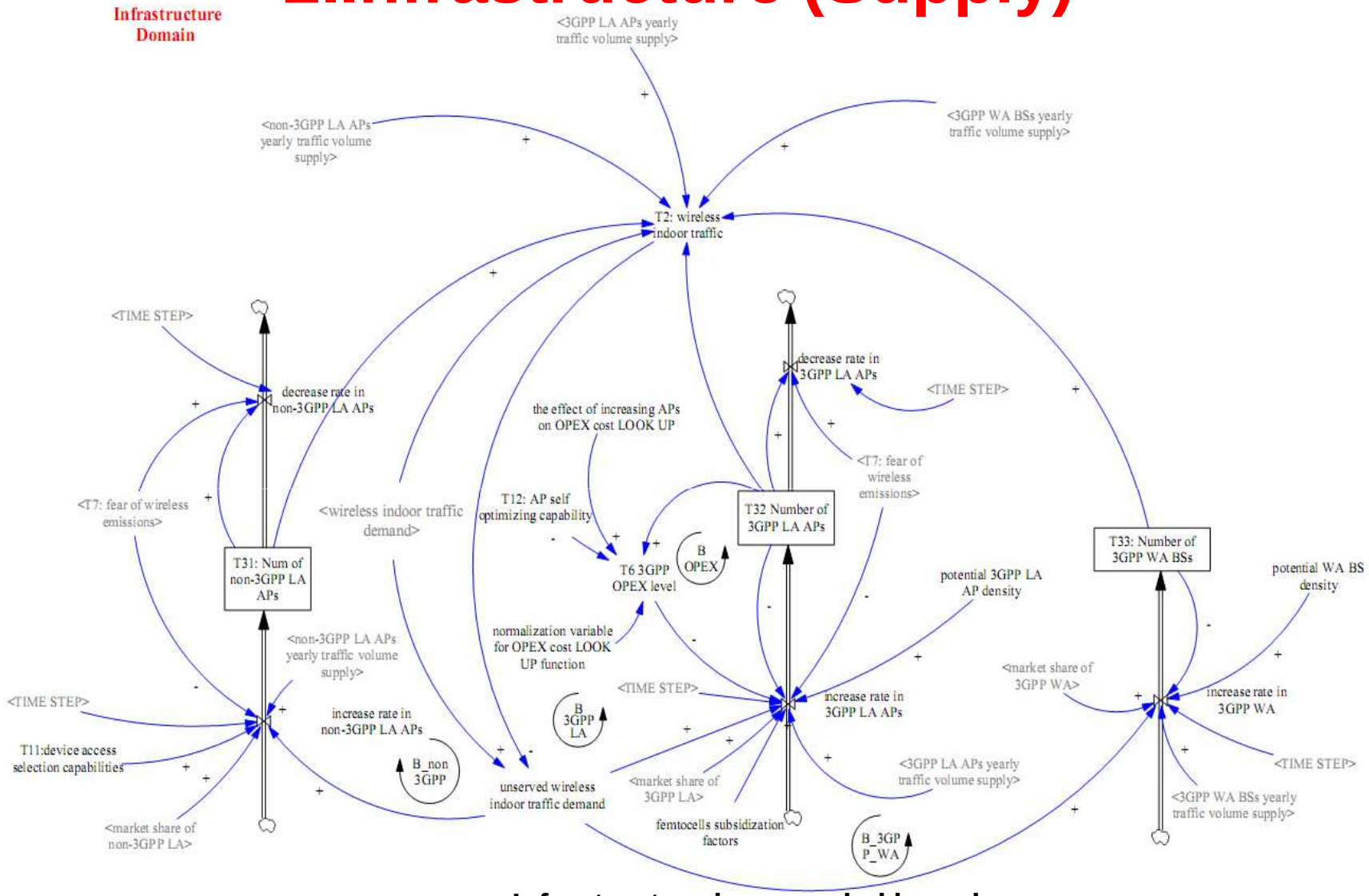
1.User Domain (Demand)



Demand based on two components

- Primary devices (includes laptops, smartphones)
- Secondary devices (household appliances etc.)

2.Infrastructure (Supply)



Infrastructure is expanded based on

- Unserved demand
- Relative market shares of each technology
- Yearly traffic volume supply of each technology

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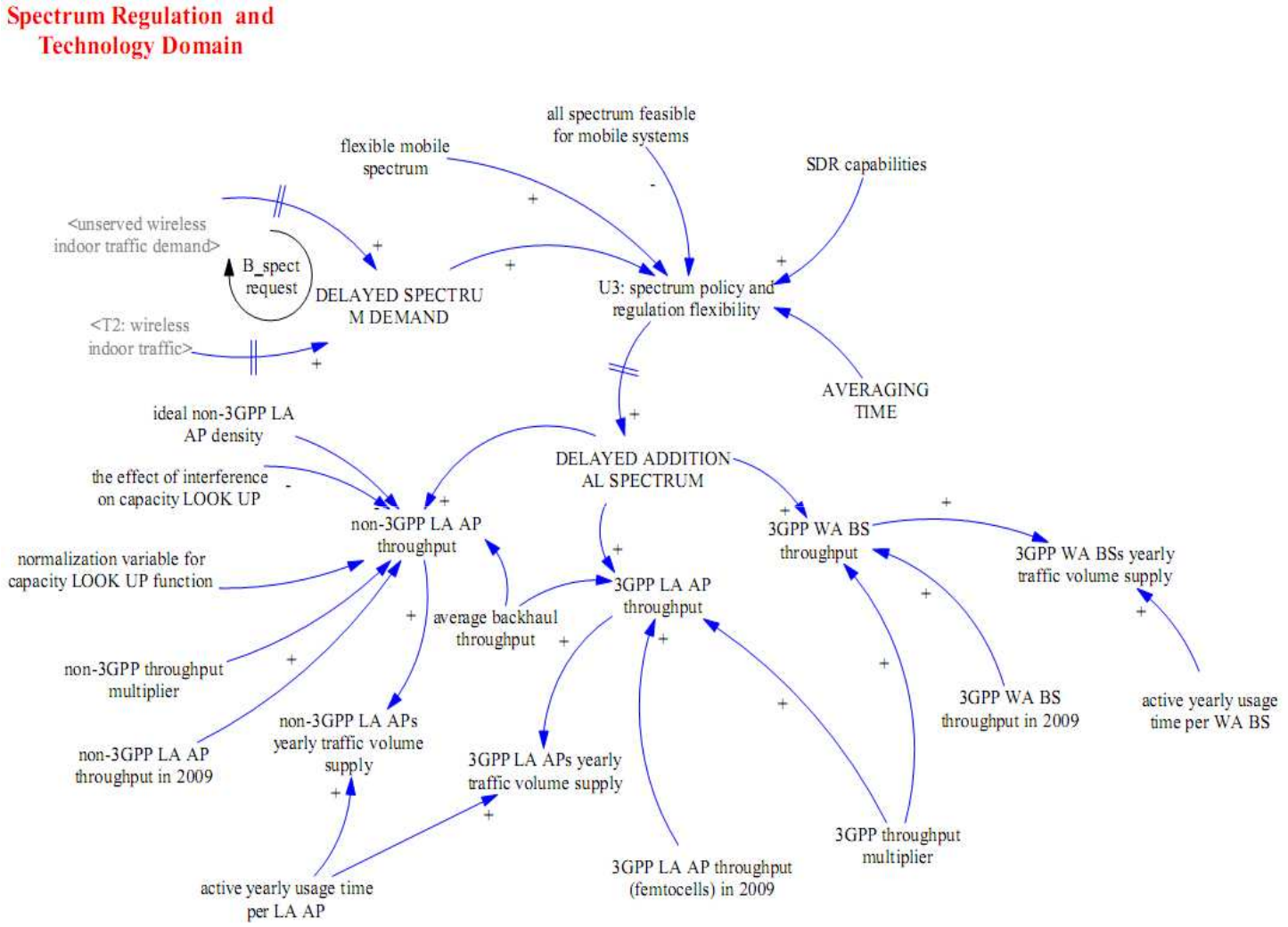
3.Spectrum Regulation and Technology

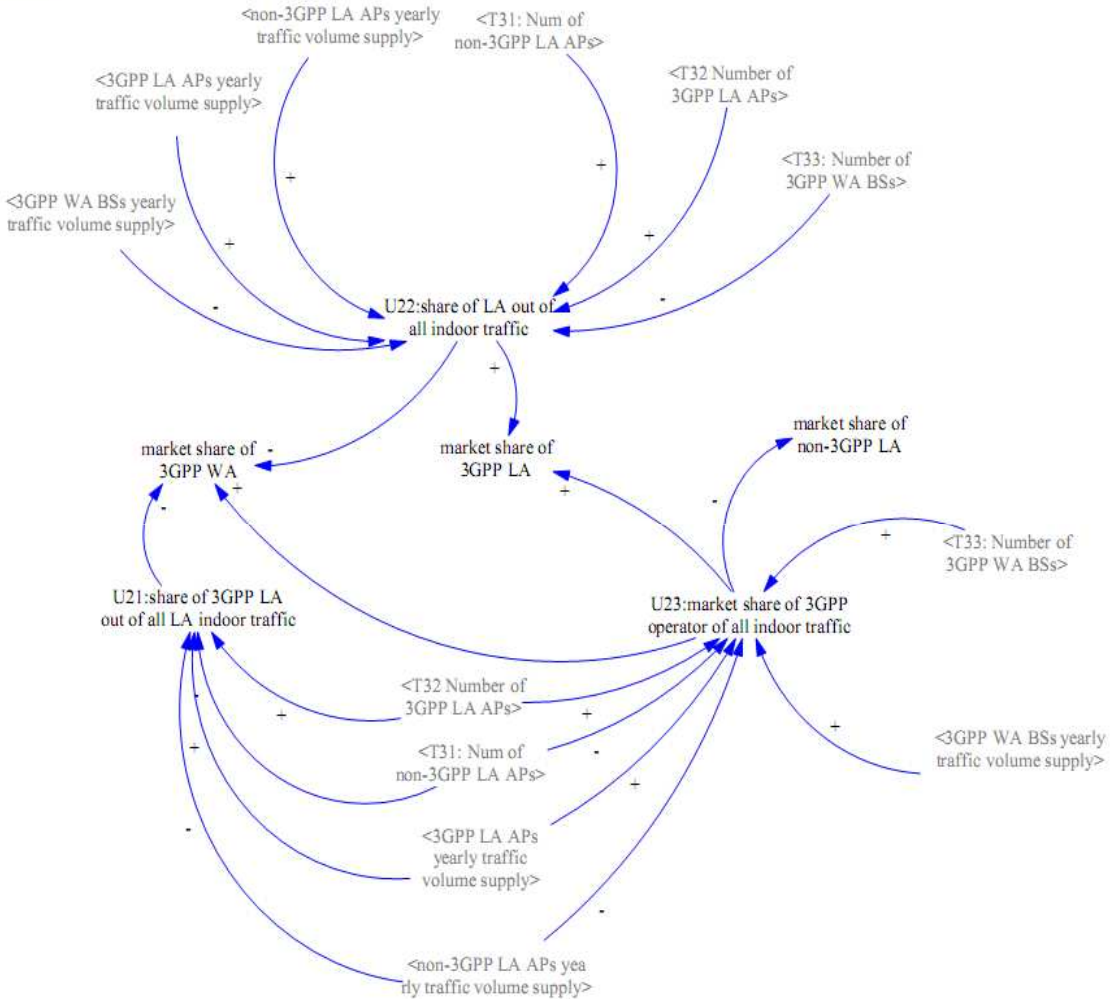


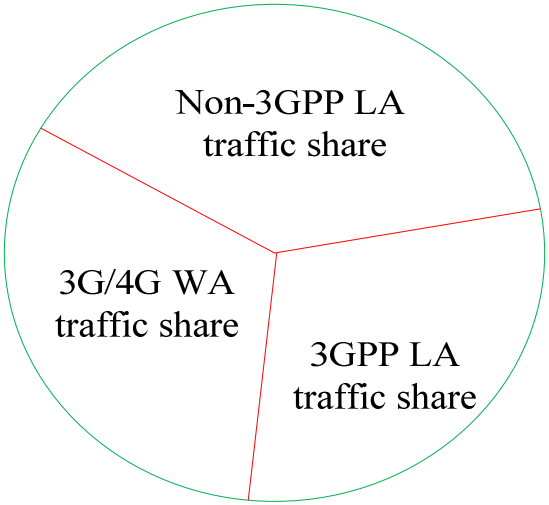
Annual traffic volume supply calculated for each technology based on

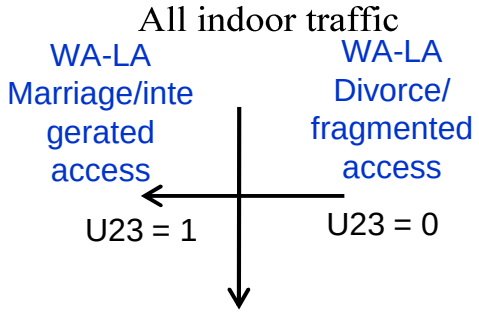
- Capacity of the technology (spectrum and technology development)
- Simple traffic model (active annual usage time)

4.Market Share

Market Share Domain

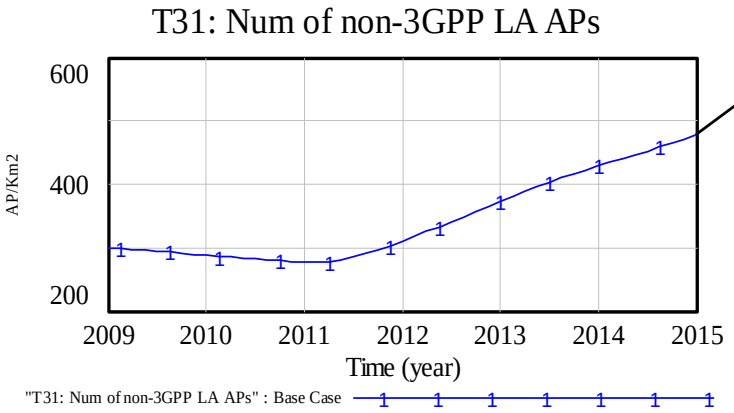




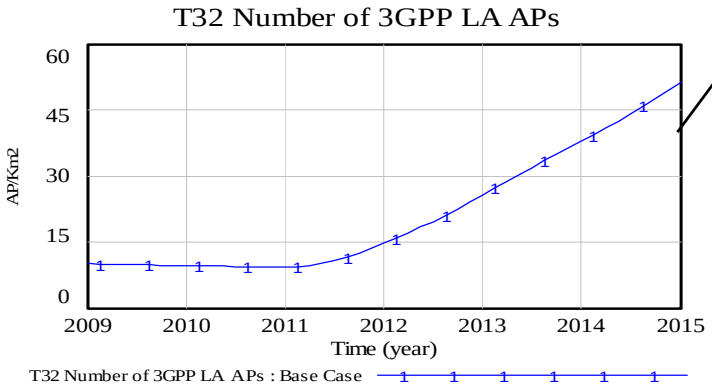


In the model variable U23 (Market share of 3GPP operator) indicates the level of fragmentation in local access provisioning

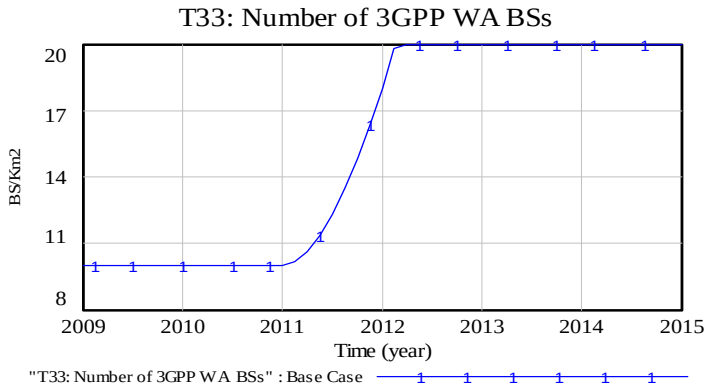
Base Case Results



150% growth



500% growth



- The maximum WA BS density in quickly reached after demand surpasses supply

Discussion

- The simulated evolution paths led to a rather fragmented indoor access provisioning scenario
  - The large installed base of WiFi (T31: Num of non-3GPP LA APs) seems to dominate (loop B_non_GPP catered to most of the unserved demand)
  - Only heavy subsidization and high AP self-optimizing ability (case 2) led to a significant market share for femtocells within the study period
  - Femtocells were however on a positive growth path (e.g. in the base case the number of femtocells grew 500 % during the study period
- System dynamic modeling is an iterative process
- One should focus on the usefulness of a model rather than on validation and verification
- Modeler's skills limit the usefulness and complexity of model

Thanks!

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