
Tools for radio planning and implementation in a cellular network

Lecturer:

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- **What we do:**
 - **Research leading to MSc. & PhDs in :**
 - Molecular physics
 - Electronics
 - Nuclear and atomic physics
 - Theoretical physics
 - Solid state physics
 - Condensed matter physics
 - Laser and optical communication
 - Communication networks
 - Software engineering
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LECTURE TOPICS:

- Introduction
- Challenges to planners
- Planning process
- Economic studies
- Planning tools
- Business simulation and modelling
- Conclusion

1. Introduction:

- **Engineers are faced with the task of planning, designing and rolling out IMT 2000 radio networks in rural and urban areas.**
- **Steps that can help the network engineers in the planning process:**
 - Conduct a feasibility study research in the area
 - Traffic analysis
 - Choosing the right technology
 - Design and dimensioning the network
 - Network simulation with software tools
 - Business modelling with software tools for economic viability

2.1 Challenges to operators:

- **New facilities** are required for rollout of the new network. These include: terminals, base stations, towers, power supply, controllers, databases, security software, transmission lines, switches and repeaters.
- **New interfaces** are also required for interconnection to existing systems.
- **New IMT 2000 services.** These include: High speed data, Internet, Mobility, Roaming, Short message service, Voice mail among others.
- **New applications** are also required for the evolved network: Voice conversation, Mobility services, Internet services, Video and other Multimedia applications.
- The new IMT 2000 system also requires **radio frequency license** before any design can be carried out.

2.2 Challenges to network design engineers

- The wireless network must have high quality
- The link must have high availability 99.9999%
- Must cover the entire service area
- High capacity, high bandwidths
- High link throughput, high traffic
- High spectral efficiency
- Mobility
- Cost effective
- Free of interferences/ high carrier to interference ratio (C/I)
- Low bit error ratio (BER) or high signal to noise ratio (S/N)

3. Planning an evolved network from TDMA to IMT 2000

■ Feasibility study:-

- The feasibility study is necessary before a network plan is prepared. The purpose of the feasibility study is to determine the economic viability and sustainability of the project. The study focuses mainly on the following:
 - Population and population density
 - Existing service if any
 - Available infrastructure e.g.. electric power, roads, buildings, towers
 - Physical features including hills, valleys, forests
 - Demand for services
 - Competitors and their market shares
 - Collection of traffic data

3.1 Traffic analysis

- The traffic collected from the proposed service area together with the demographic figures must be analyzed in order to determine economic viability before any investment can be undertaken. Some of the parameters used in traffic analysis are listed below:
 - Demand
 - Traffic offered
 - Traffic carried
 - Calling rate and call probability
 - Call completion rate
 - Busy hour call attempts
 - Blocking probability
 - Grade of service expected
 - The Erlang formula is useful in the calculation of traffic. After carrying out traffic calculations we will know the capacity of the system a, the number of circuits required, calling patterns, QOS and many other factors required for the dimensioning of our system.

3.2 Technology Studies:

- The technology study shall involve the comparison of several competing technologies for our proposed system for example TDMA, CDMA 2000, TDD, CDMA 1X EVDO, UMTS, WCDMA, EDGE, TDD etc.
- The systems will be compared with the requirements for our system in terms of capacity, services, QOS, Reliability, standards. Some of the parameters used for evaluation of technology are:
 - User data rates offered
 - Type of terminals
 - Access subsystem
 - Transport subsystem
 - Service subsystem
 - Mobility subsystem
 - Security subsystem
 - Power consumption
 - Immunity to EM Interference
 - Availability of spare parts
 - Interface with existing and planned systems
 - Conformity to ITU-T and ITU-R standards

3.3 Economic study and analysis.

- Economic analysis is necessary before investment in any project. It is necessary in order to establish whether the investment cost will result in revenue and profit. It will also show whether the business is economically viable and whether the market is big enough.

3.4 Market Research:

- determine subscriber base at present and projections for the proposed service area
- determine market trends in terms of tariffs and airtime charges
- customer penetration analysis
- Growth in revenues estimation
- Costs of transition to new technology
- Costs of marketing, advertising, acquisition, retention, licensing, operation, real estate, content and application development
- equipment costs (Capex)
- Interconnection costs
- Estimation of Opex costs
- Development of a revenue structure
- Computation of net present value (NPV)

3.5 Sensitivity Analysis:

- Sensitivity analysis is carried out in order to prove whether the proposed investments will yield any profits in the short, medium and long terms. It is an important index of profitability for the investors.

3.5.1 Inputs for Sensitivity Analysis:

- Traffic demand
- Service penetration
- Tariff erosion
- Service offering
- Gross Domestic product of the country (GDP)
- Capex and Opex
- Transition costs

3.5.2 Outputs of sensitivity analysis:

- Internal rate of return -IRR
- Net Present Value –NPV
- DPP
- Average Return on investment per user (ARPU)
- Revenue projections
- Cash flow
- Business plan

4. Design of the evolved IMT 2000 Network:

- On conclusion of sensitivity analysis and business planning, an operator can now embark on the work of designing the network. The following factors should be taken into consideration by the design engineers:

4.1 Design parameters

Traffic in milli Erlangs /subscriber	36
Grade of service & blocking probability	0.5 blockbg
Cell Radius	1 km
Available frequencies	7, 13,28 GHz
Frequencies in use	7,13
Interfaces to existing systems	V 5.2, R2, R703
Power supply sources	110 v ac
Earth system	None
Access and real estate issues	
RF License certificate	

4.2 Use of Network Planning Tools:

- Several radio network planning tools are available.
 - One such tool for demonstration is Witview 2000 to be demonstrated at the seminar.
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5. Business modelling and simulation

- There are several business modelling tools available in the market today for assisting business planners in coming up with positive results.
 - Some of the Tools e.g. STEM to be demonstrated at the seminar.
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6. Conclusion:

- Transition to IMT 2000 services is very important for network operators because it brings about new applications and services that are required by customers. However the operators must be prepared to invest some money in CAPEX, OPEX and human resource development. There is also the issue of availability of frequency spectrum that must be addressed with the relevant regulators in the developing countries before any investment can be done in IMT 2000 systems. Proper design and planning of the IMT 2000 systems are necessary using the available software tools as demonstrated in this paper.
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