КОМПЮТЪРНИ МРЕЖИ и КОМУНИКАЦИИ

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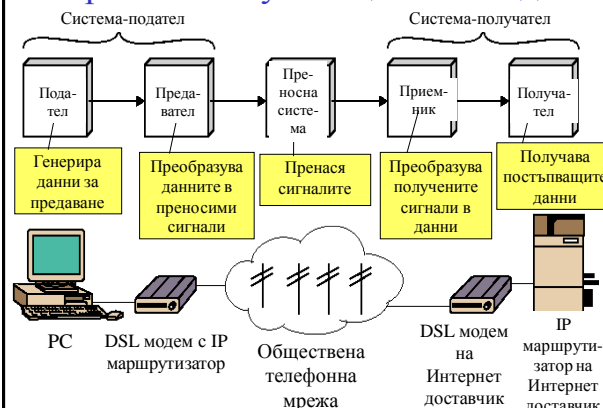

Информация за учебната дисциплина

- Учебни материали
  - **http://delc.fmi.uni-plovdiv.net/library**
- Оценяване
  - Упражнения: MAX=30 т.
  - Писмен изпит: MAX=80 т.
    - eTest + (опционна) задача от учебното помагало

Въведение

Опростен комуникационен модел

Ключови комуникационни задачи (1)

- Ефективно използване на преносната система
  - Оптимално, ефективно разпределение на наличните ресурси
- Интерфейси
- Генериране на сигнали и:
  - Оптималното им разпространение
  - Правилното им тълкуване от страна на приемника
- Синхронизация между комуникиращите страни
- Управление обмена на съобщения
  - Правила за `разговор`
- Контрол
  - Контрол на грешките
  - Контрол на потока данни
 - Контрол на задръстванията (в мрежата)

Ключови комуникационни задачи (2)

- Адресация и маршрутизация
  - Множество устройства, споделящи съоръжения за пренос.
- Възстановяване
  - Подновяване на комуникацията от точката на прекъсване
- Форматиране на съобщения
  - Битово-ориентирано, байтово-ориентирано...
- Сигурност
  - Данни, получени само от предназначени получатели, и непроменени.
- Мрежова сигнализация и управление
  - Конфигуриране на системата
  - Следене на състоянието й *(monitoring)*
  - Откриване на повреди и претоварвания
  - Планиране на бъдещото й развитие

Работа в мрежа *(networking)*

- Комуникация тип „точка-точка"
  обикновено НЕ е практична
  - Устройствата могат да са твърде далеч
    едно от друго
  - Голям брой устройства (**N**) води до
    огромен брой връзки **N(N-1)/2**
- Решението е да се използва
  телекомуникационна мрежа

Опростен мрежов модел
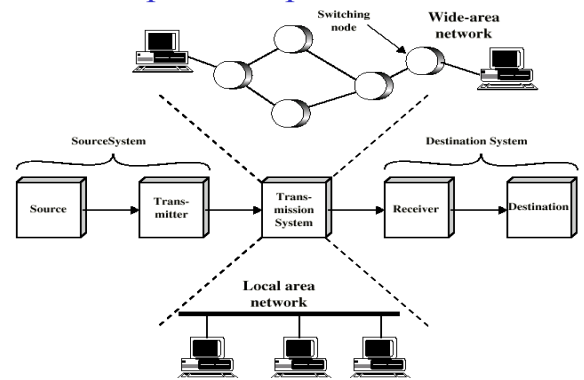
Телекомуникационни мрежи

- Дефиниция
  - <u>Множеството комутиращи/маршрутизиращи възли и
    съединения помежду им</u>, позволяващи на крайните възли
    да имат достъп до телекомуникационна инфраструктура,
    поддържаща набор от услуги.
- По принцип всички мрежи са
  телекомуникационни
  - Мрежи за данни, компютърни мрежи, телефонни мрежи,
    мобилни клетъчни мрежи, радио/телевизионни
    разпръсквателни мрежи и др.
- В миналото е имало разлика
  - Компютърните мрежи са пренасяли само данни,
    генерирани от компютри; телефонните мрежи са
    пренасяли само глас и т.н.
- Но днес вече няма разлика
  - Съвременните мрежи (например Интернет) пренасят *глас
    + данни + видео* (известно още като *triple play*)!

Компютърни мрежи

- Взаимно свързване на **компютри**
  - 2 компютъра са взаимносвързани,
    ако са в състояние да обменят данни.
- Причини за свързване на компютри в
  мрежа:
  - Споделяне на хардуерни ресурси
    (дискове, принтери, модеми, скенери и др.)
  - Споделяне на приложен софтуер (MS Office)
  - Спестяване на пари (*downsizing process*:
    от големи машини към множество разпръснати
    малки интелигентни компютри)
  - Увеличаване на производителността
    (улесняване споделянето на данни
    между различни потребители)

Компютърни мрежи: Видове

Различни **критерии**:
- **Собственост**
  - <u>Обществени</u> (Internet) или <u>частни</u> (собственост на компания)
- **Географско покритие**
  - <u>Телесни</u>: Body Area Networks (<u>BANs</u>), <u>Персонални</u>: Personal
    Area Networks (<u>PANs</u>), <u>Локални</u>: Local Area Networks (<u>LANs</u>),
    <u>Регионални</u>: Metropolitan Area Networks (<u>MANs</u>),
    <u>Глобални</u>: Wide Area Networks (<u>WANs</u>)
- **Предавателна среда**
  - <u>Кабелни</u> (медни или оптични кабели) или <u>безжични</u>
    (радио, микровълнови, инфрачервени лъчи)
- **Топология**
  - <u>Звезда</u>, <u>дърво</u>, <u>шина</u>, <u>кръг</u>, <u>mesh</u>
- **Тип на предаване**
  - <u>Broadcast/multicast</u>, <u>point-to-point</u>, <u>peer-to-peer</u>
- **Мобилност**
  - <u>Фиксирани</u> или <u>мобилни</u>

Взаимносвързани мрежи *(internetworks)*

- Или **интермрежи** / **интернети** (**internets**)
- Получават се при свързване на 2 или
  повече мрежи, които могат да
  комуникират помежду си.
- Най-известната интермрежа е световната
  мрежа **Интернет** (**Internet**), съставена от
  стотици хиляди взаимносвързани мрежи.
  - <u>Мрежа от мрежи</u>

Мрежи:
Съвременни тенденции

- Развитие диктувано от приложенията *(application-driven)*
- Интегрирани телекомуникационни мрежи
  – Пренасяне на глас + данни + видео
- Конвергенция на мрежи
  – От гледна точка на интерфейсите за достъп, размера на пакетите, доставката на услуги.
  – Конвергенция на фиксирани и мобилни мрежи *(Fixed to Mobile Convergence, **FMC**)*
- Безшевни структури *(seamless)*
  – Мета-мрежи
- Увеличаване броя на услугите
- Необходимост от развитие базирано на <u>референтни комуникационни модели</u>

TOP 10 COMMUNICATIONS TECHNOLOGY TRENDS (2015)

- **5G**
As the next step in the continuous innovation and evolution of the mobile industry, 5G will not only be about a new air interface with faster speeds, but it will also address network congestion, energy efficiency, cost, reliability, and connection to billions of people and devices. In 2014 we heard of new antenna/RF technologies (Massive MIMO, wider bandwidths), proposed deployment of small cells in higher mmWave frequencies, shorter transmission time intervals, reduced latency, and possibly new modulation methods beyond OFDM. With a 2020 commercialization horizon, 2015 be the year when we move from these concepts to technology trials and standards development. And we shall see if/how this year's ITU World Radio Conference (WRC-15) tackles 5G's spectrum aspects.
- **FIBER EVERYWHERE**
2014 was the year of "fiber everywhere" propelled by efforts to improve connectivity and address demand increases from the use of high definition video, 3G/4G, streaming, podcast and other broadband services. This increased demand exposed existing bottlenecks in the communications infrastructure, and the solution that the doctor prescribed was a fresh new round of investments and activity in fiber (FTTx). In developed markets, FTTH/FTTC dominated deployments, and will continue to do so into 2015. In the backbone network, Carrier Ethernet is well underway and it will continue to make inroads towards 100/400G switching hardware deployments, and around Tb/s of bandwidth.

TOP 10 COMMUNICATIONS TECHNOLOGY TRENDS (2015)

- **VIRTUALIZATION, SDN & NFV**
The "software-ization" of Telco continued throughout 2014. The year saw open source going main stream with the news that Midokura and Microsoft, the last two major players with closed source solutions, released their source code and went open. In 2015, the adoption of OpenStack, OpenDaylight, OpNFV for software and services, and Open Compute for hardware will support more virtualized, more open source network computing platforms and architecture.
- **EVERYWHERE CONNECTIVITY for IoT & IoE**
Over the last year we have seen heightened interest in the Internet of Things (IoT) and of Everything (IoE) including several acquisitions by major players such as Google's purchase of Nest Labs for $3.2 billion. Bob Metcalfe, inventor of the Ethernet, said that the power of a network increases proportionally by the square of the number of users (Metcalfe's Law) which puts IoT –forecasted to be 50 billion connections by 2020- in a powerful and strategic position. The challenge that IoT faces is that everything sits in isolation thus an IoT standard is a must, and many see this happening in 2015.

TOP 10 COMMUNICATIONS TECHNOLOGY TRENDS (2015)

- **COGNITIVE NETWORKS, BIG DATA**
Communication systems handle volumes of data generated by embedded devices, mobile users, enterprises, contextual information, network protocols, location information and such. It is a vast amount of information: A global IP backbone generates over 20 billion records per day, amounting to over 1 TB per day! Processing and analyzing this "big data" and presenting insights in a timely fashion are becoming a reality with advanced analytics to understand the environment, to interpret events, and to act on them. This is a positive development that helps unleash the intelligence in communication systems where networks are no longer labeled "dumb pipes" but as smart cognitive networks.
- **CYBERSECURITY**
2014 was most remarkable for demonstrating that everything connected to the Internet can, and will be hacked. On daily basis we heard of retailers (Target, Home Depot, Neiman Marcus), financial institutions (Chase), technology companies (Snapchat, eBay, Sony) being hacked. No one is cyber-safe, and the road to the future leads through new cybersecurity technologies beyond current perimeter firewall-like defenses. The coming year will bring significant changes in the industry as it responds to recent increases and sophistication of cyberattacks. We will see better solutions to protect devices and endpoints, advances in the default use of encryption, in authentication schemes, and in BYOD solutions.

TOP 10 COMMUNICATIONS TECHNOLOGY TRENDS (2015)

- **GREEN COMMUNICATIONS**
It is being reported that communications technologies are responsible for about 2-4% of all of carbon footprint generated by human activity. This highlights the need to focus on managing these numbers, and Green communications is doing just that. The trend is tackling first mobile networks because of their high energy use. Basestations and switching centers could count for between 60% and 85% of the energy used by an entire communication system. Environmentally friendly batteries, renewable energy sources, and intelligent management of the power systems are some of the proposed solutions. Besides this mobile network focus, there is a 2015 and beyond trend to manage total energy usage, compute-to-consumption ratios and performance KPIs for best in class green operations.
- **SMARTER SMARTPHONES, CONNECTED SENSORS**
The indisputable rock-start of devices is the smartphone, and its future can't be brighter. In 2014 we saw that only a few days after the iPhone 6 was released, there are already articles being written about the next-generation iPhone 7. Size, shape, and capabilities of these ubiquitous communication devices continue evolving, and so are prices which, driven by cost and performance improvements in digital technologies, are falling rapidly. The average selling price of a smartphone went down in 2014, and we expect this to continue in 2015 with low-cost OEMs such as Xiaomi and Lenovo leading the trend.
Beyond smartphones, tablets, connected sensors and body-worn wearables will also make headlines. Connected sensors will find their way into vehicles (smartcards), into urban areas (smartcies) and into our infrastructure (smartgrid).

TOP 10 COMMUNICATIONS TECHNOLOGY TRENDS (2015)

- **NETWORK NEUTRALITY, INTERNET GOVERNANCE**
The Internet has been operating since its inception under "open" principles, i.e. an open standards-based network that treats all traffic in roughly the same way, i.e. no connection blocking, bandwidth transparency, universal connectivity, and best effort service. Can these principles be sustained in a new word of data-hungry applications and services? Is regulation needed to prevent traffic throttling, unfair raise of fees, and construction of preferential high-speed Internet lanes? In 2014, Network Neutrality (NetNeutrality) discussions covered these questions in the context of ISPs transit and peering, and CDNs. Governments and institutions around the world will continue working on it during 2015. They will also be working on the Internet governance transition plan as current ICANN framework is set to expire in October.
- **MOLECULAR COMMUNICATIONS**
Molecular communication is an emerging paradigm where bio-nanomachines (e.g., artificial cells, genetically engineered cells) communicate to perform coordinated actions. Unlike traditional communication systems which utilize electromagnetic waves, molecular communications utilize biological molecules both as carriers and as information. The advantages provided by this "molecular" approach to communications are size, biocompatibility, and biostability. Examples of applications are drug delivery system (DDS), bio-hybrid implants, and lab-on-a-chip (LoC) systems. This trend is not ready for mass market but with an approach so radically different to Today's communications, following its developments is a must.