Networking & Telecommunications Curriculum and Research at CDM

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BS in Network Technologies
- Focuses on applying network technologies to design, deploy and manage wired and wireless networks.
- The scope covers broadband Internet access technologies, interconnection technologies, network convergence, and network security.
- Three concentrations

Three NT Concentrations
- **Standard Concentration** – specialized in network design, system management, service deployment, and product/vendor evaluation.
- **Security Concentration**: specialized in security technologies, security administration and management, and security infrastructure design.
- **Application Developer Concentration**: specialized in application development for network services with course work focused on software development and network programming, in addition to network technologies and protocols.

BS-NT Requirements

<table>
<thead>
<tr>
<th></th>
<th>Major (Networking)</th>
<th>Liberal Studies</th>
<th>Open Electives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Sophomore</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Senior</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>subtotal</td>
<td>20</td>
<td>19</td>
<td>9</td>
</tr>
</tbody>
</table>

Total: 48 courses = 192 credit hours

MS in Network Engineering and Management (NEM)
- Train professionals to meet current industry demands for innovative network designs, and the development of new network applications and services for business enterprises and the network providers.
- This program offers theoretical and applied study of the design, configuration and management of converged communication networks.
- The program was first offered in 1987 and has been continuously updated since then. It continues to be one of the largest and most respected graduate programs in networking in the U.S.

MS-NEM Requirements

<table>
<thead>
<tr>
<th>Phases</th>
<th>Course Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite</td>
<td>Four undergraduate networking course</td>
</tr>
<tr>
<td>Foundation</td>
<td>Three core networking course</td>
</tr>
<tr>
<td>Advanced Phase</td>
<td>Four required networking courses Three major electives</td>
</tr>
<tr>
<td>Open Electives</td>
<td>Two CDM courses</td>
</tr>
<tr>
<td>Capstone</td>
<td>One course</td>
</tr>
</tbody>
</table>

Total: 13 graduate courses = 52 credit hours
Network Skills Development
- Theories on telecom and data networks
- Local Area Network (LAN) design, configuration, and management
- Broadband access technologies (xDSL, Frame Relay, ATM, MPLS, Fiber, Metro LAN etc.)
- Converged multimedia networks and wireless networks
- Network Security
- Network application and service development
- Network simulation (ns2 and Opnet)
- Practical experience through hands-on exercises, internships, and industry tours

Network Research Projects
- Wireless Security
- VoIP Traffic Engineering
- Network Configuration Management
- Network Security Management
- Networking Education

Project I: Wireless Denial of Service (DoS) Research

802.11 Networks
TCP performance under DoS

Research Solutions to Protect DoS Attacks (802.11 networks)

II: VoIP Traffic Engineering (joint research with Neutral Tandem)
Daily-effect model

\[ \log(\lambda(t)) = \mu + \sum_{j=1}^{K_o} [\alpha_i \sin(\omega_o t) + \beta_i \cos(\omega_o t)] + \sum_{j=1}^{K_o} \gamma_j I_j(t) \]

where:
- \( \lambda(t) \) is a function of time.
- \( I_j(t) \) is day Indicator function where \( j \) is the day of the week
- \( K_o \) is the number of harmonics in the model
- \( \mu \) represents the model central tendency without daily effects
- \( \gamma_j \) is the effect of day \( j \)
- \( \alpha_i \) and \( \beta_i \) are the contribution of the \( i \)th harmonic to the model
- \( \omega_o \) is the pattern repetition frequency: \( 2\pi/T \) where \( T \) is the number of seconds in one day (86400)

Model Validation

- We Used Maximum Likelihood Estimation to fit the proposed model to the actual data.

Using the model for Prediction

(cont'd)

Predicted data against real data for Week 2 and Week 3

Project III: Network Management
(supported by Tail-f in Sweden)

<table>
<thead>
<tr>
<th>Command-Oriented</th>
<th>Vendor specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable-Oriented</td>
<td>SNMP/MIB</td>
</tr>
<tr>
<td>Object-Oriented</td>
<td>* CORBA</td>
</tr>
<tr>
<td>Document-Oriented</td>
<td>* XML-Based</td>
</tr>
<tr>
<td>Transaction-Oriented</td>
<td>NETCONF</td>
</tr>
</tbody>
</table>

NETCONF

- A new Protocol from IETF
- It is designed to address many current issues of network management.
- XML-based and Transaction-Based
  - The XML standard is well defined
  - The XML Schema allows flexible definition of the structured management information
  - download/upload of complete device configuration
  - human-readable
  - cost-effective to develop new applications and services
- Integration with security infrastructure

Configuration Modeling

- High-level Requirements
- High-level language
- Semantic Modeling
- Network Management Protocol
- Data modeling
- Physical network devices

Define the syntactic and verifiable rules which describe requirements and goals
Thank You