Utility Automation Research Centre

UARC division has a very long and interesting history in CPRI. In the very beginning after CPRI was established, CPRI started using computers for solving electrical power systems and structural engineering problems. The journey of computers in CPRI started during early 1960's with the development of computer programmes on the first and oldest computer in Bangalore namely Elliot 803 at HAL. During the second decade i.e 1970–1980 the mainframe computer IBM 360/44 and then DEC (Digital Equipment Corporation) 1090 which replaced IBM 360/44 in IISc were used for power system, High voltage and transmission tower testing related problems. During fourth decade i.e. 1990–2000 the IT infrastructure witnessed a phenomenal growth. Tens and hundreds of Personal computers were procured and upgraded from time to time. Local Area Network was created during 1997–1998. During the fifth decade i.e. 2000–2010 CSET division has come into full pledged operation. The development of CPRI Automation System (CAST) started during early part of 2000s aiming at the automation of workflow, testing and other support activities. The IT in the form of, Intelligent Meters (IM) became a reality during early part of 2010. Followed with this initiative "Conformance Test Laboratory" was established during 2004.2005. "Gyanshakthi" a knowledge management and digital library intranet portal was launched during 2005 which facilitated sharing and seeking knowledge among CPRI fraternity.

1.0 INTRODUCTION

UARC division has a very long and interesting history in CPRI. In the very beginning after CPRI was established, CPRI started using computers for solving electrical power systems and structural engineering problems. The journey of computers in CPRI started during early 1960's with the development of computer programmes on the first and oldest computer in Bangalore namely Elliot 803 at HAL. The untiring journey of computers continued with the use of mainframes like IBM 360/44, DEC 1090, micro/mini computers like ECIL MICRO 78, BPL IDB 800, MICRO VAX, Workstations like Silicon Graphics, IBM, SUN, etc., Personal Computers and Servers of various makes like IBM, Compaq, HP, Zenith, Acer, DELL, etc.

The use of computer for non-scientific purposes started during 1980 beginning with CPRI accounts applications. A big turn took place during late 1990's when the use of computers percolated to the several activities of CPRI. In mid 1990s Center for Software Engineering and Training (CSET) was formed. The CEST was entrusted with the big task of bringing in IT automation in all walks of CPRI like workflow and testing and office automation. CSET implemented Local Area Network (LAN) at Head Office, Bangalore and at units in various parts of the country. The email facility was provided to the employees. Website for CPRI was hosted in the Internet. In 2005 CSET was renamed as Information Technology and Implementation Division (IT&ID). Digital Library and Knowledge Management System portal was launched. Valuable IT resource was built, enlarged, expanded, shared and managed for the effective use in CPRI for technical, business and office automation purposes.

While in IT, IT&ID spread itself in to power sector automation by initiating work on power system protocols for metering, sub-station automation and later in to smart grid. Befitting its new role in power sector IT&ID was christened

as Utility Automation Research Centre (UARC). Following sections provide the brief description of the journey during each decade.

1.1   1961–1970

During the first decade i.e. 1960–1970 Computer Section was part of Power Systems Division of CPRI. The programs were developed in Autocoder language for ELLIOTT 803 computer (having 5 channel paper tape as input medium) situated in Hindustan Aeronautics Ltd. (HAL), Bangalore. The programs related to grounding for large substations, load flow, optimal location of capacitors, Stress analysis of transmission line towers (structures) and other in-house problems.

The untiring journey of computers continued with the use of mainframes like IBM 360/44, DEC 1090, micro/mini computers like ECIL MICRO 78, BPL IDB 800, MICRO VAX, Workstations like Silicon Graphics, IBM, SUN, etc.

1.2   1971–1980

During the second decade i.e 1970–1980 the third generation computer IBM 360/44 the first computer installed in IISc in 1970 and then the late third generation computer DEC (Digital Equipment Corporation) 1090 which replaced IBM 360/44 in 1979 were used for power system, High voltage and transmission tower testing related problems. Both these computers as well as the CDC computer used standard 80-column IBM cards which were not only bulky but also suffered from card jam problems. For today's users these are all history. During mid 1970's CPRI procured DCM 1101 programmable calculator. This calculator was used to calculate and print the percentage loads for the purpose of loading the transmission test tower. The calculator was also used for solving mathematical numerical problems to help the researchers. During 1978 CPRI procured Micro-78 an 8080 microprocessor computer of ECIL make (having 8 channel paper tape and a teletype writer).

FROM L-R: SHRI/S RAM MOHAN. DY DIR. HV LAB, S. SRIDHARAN. DY.DIR, PLANNING. S. PARAMESWARAN. DY.DIR.   POWER   SYSTEMS   DIVISION.   G.S. LAKSHMINARAYANA, DY.DIR. COMPUTER DIVISION. CS.SRINIVASAN, DIRECTOR. CPRI

1.3   1981–1990

During the third decade i.e. 1980–1990 CPRI procured the following general purpose computers (the list is not complete):

1. IDB-800 a micro computer (initially 8 bit and upgraded to 16 bit processor) CP/M like OS and supported with Fortan and Basic program development platforms and word processing program 'Autoscib' and Side Click for creating programs and documents.

2. IBM PC (later upgraded to XT/AT/386/486, etc.) with DOS, Windows 3.1 OS and supported with Fortran and Basic program development platforms and word processing program Wordstar/Editor for creating programs and documents.

3. DEC Micro Vax with VMS OS and Fortran. Other computers procured were special purpose like PDP 11, SUN, IBM, Silicon Graphics Workstations, etc., for power system analysis and simulation.

Programs which were run on all the earlier computers were ported to the aforesaid computers. Some of these programs were also used for the design of narrow based self supporting transmission towers. Further, programs developed for the problems in the area of power

system, transmission, high voltage, simulation, payroll and financial accounting system (FAS). The software for location of substation and rationalization of primary distribution system (DIST PLAN) were developed.

1.4   1991–2000

During fourth decade i.e. 1990–2000 the IT infrastructure witnessed a phenomenal growth. Tens and hundreds of Personal computers were procured and upgraded from time to time. Local Area Network was created during 1997–1998. Internet and email facilities were provided to the users. CPRI and units located at other locations started using Microsoft Windows and Office Automation software.

Testing Automation

CPRI envisaged the work of automation of research, testing, consultancy and support activities using computers and Information and Communication Technology (ICT) tools. The above work was taken up as the Capital Project under X National Plan namely "The Centre for Software Engineering and Training (CSET)", sanctioned by Ministry of Power, Government of India during May 1998 with a budget of 3.74 crores. In this connection, M/s. C-DAC made a study of the processes related to the "Automation" activities of CPRI and submitted the "Feasibility Report (FR)" describing the processes identified for automation, the users' requirements, ICT

infrastructure tools, application software and its product development life cycle. As proposed in the aforesaid FR, CPRI entrusted the work of development of application software titled as "CPRI Automation SysTem (CAST)". As said in the FR, CAST is the integration of "Divisional Automation System (DiAS)" which was meant to automate at the divisions/units level activities viz. Work Flow (W/F) and Testing, Maintenance and Calibration, Consultancy, R&D, Divisional Purchase, Quality, etc. and further linking to the support activities like Administration, Accounts, Purchase and Stores, Marketing and Publicity, Planning and Management Information System. M/s. C-DAC have developed many software modules and installed at various divisions.

Desktop computers were procured and LAN was strengthened. Capacity building programs were organized for the software developers as well as other users of CPRI. Computers were put into use for research, consultancy, testing, automation, accounts and other general purposes.

1.5   2001–2012

During the fifth decade i.e. 2000–2010 CSET became an independent Division. Development of application software "CAST" was continued. A project to establish Digital Library and Knowledge management System (DL&KMS) was sanctioned in March 2003 with a budget of 1.50 crore under X National Plan. In 2005 CSET was renamed as Information Technology and Implementation Division (IT&ID). The DL&KMS project was completed with the help of the consultant Prof. S. Sadagopan, Director, International Institute of Information Technology, Bangalore. The DL&KMS web portal was launched in 2006 coinciding with the National Workshop on Knowledge Management was organized at CPRI during 2006. The DL&KMS christened as "Gyanshakthi" was an intranet portal which facilitated sharing and seeking knowledge among CPRI fraternity.

While in IT, IT&ID spread itself in to power sector automation by initiating work on power

system protocols for metering, sub-station automation and later in to smart grid.

1.6 PROTOCOL LABORATORIES

1.6.1 Metering Protocol Laboratory

The IT in the form of, Intelligent Meters (IM) became a reality. These meters are being read automatically or remotely by various techniques. In some utilities these meters are becoming part of SCADA systems which are put together by manufacturers and system integrators. The process of remote reading a meter requires use of a common protocol to exchange required information as and when needed. The IM in use then were supporting varieties of protocol which either delayed or eluded implementation of AMR application.
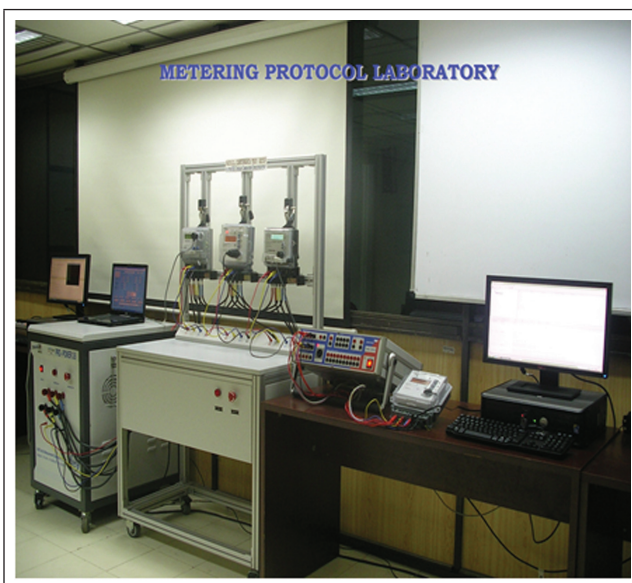
IT&ID has studied this problem and found that open metering protocols are the way out. It identified an IEC standard for this purpose and conducted the International event "Tutorial on International Electricity Metering Protocol (IEC-62056)" during 30 November, 2004 which was attended by more than 250 delegates. IT&ID followed this initiative with establishment of "Conformance Test Laboratory" in 2004–2005. While India was debating on this protocol International manufacturers from Korea have availed CPRI test facility for conformance testing. In India the drive was further continued and when RAPDRP was launched the concerned expert committees constituted for the purpose have recommended the adoption of open protocol and BIS took up the work on adoption of IEC-62056 standard and development of an Indian Companion Specification (ICS). In 2010 the draft document was accepted. Simultaneously CPRI laboratory was augmented to meet the requirements of ICS and this new laboratory was made available to the country in Feb.2010. BIS formally released the Indian standard IS-15959 in 2011. This is a significant contribution by CPRI to the power sector.

1.6.2 Substation Automation System Laboratory

Simultaneously IT&ID has identified that world over the electrical sub stations are migrating to the digital domain through adoption of IEC 61850 – "Communication Systems and Networks for Substations". In 2006 Organized the First International Workshop on IEC 61850 the standard for Communication Networks and Systems in Substations by inviting the expert faculty from abroad. This event was attended by more than 350 delegates. In 2008 the Conformance Testing Laboratory for Intelligent Electronic Devices compliant to IEC-61850 was set which was later accredited by Utility Communication Architecture International Users Group (UCAIUG) as Level A (third party independent) laboratory the second to get that status in the world.

1.6.3 Automation

IT&ID continued its expansion by bidding for automation projects in transmission and distribution. A few of the projects as on date are:

- SCADA DMS Consultant for the state of Andhra Pradesh under RAPDRP Scheme.

- SCADA DMS Consultant for Puducherry under RAPDRP Scheme.

- Project Management Consultant BESCOM's Bangalore City DAS project funded by JICA.

- Integrated Extended SCADA project for KPTCL covering over 1200 substations, 16 Control Centres, with Main and Disaster Recovery Control Centers spread over the entire state of Karnataka with a mix of communication technologies.

- BESCOM IT Strategy.

- Review of Technical Specification for HESCOMs Total Revenue Management.

- Consultancy for Implementation of SCADA for water supply to Mysore for KUWSDB.

- Preparation of DPR for Cochin City Automation.

Befitting its new role in power sector IT&ID was christened as **Utility Automation Research Centre (UARC)** in 2011.

1.6.4 Smart Grid

The involvement in the automation and protocols has positioned CPRI to jump in to the smart grid without any difficulty. It was awarded the maiden smart grid project in India – The design and development of smart grid pilot for BESCOM supported by USAID. This was followed by Central Power Distribution Company a DISCOM in Andhra Pradesh choosing CPRI as the consultant for their Smart Grid Pilot project.

CPRI is contributing at the national level Chairman as well as member of working various

groups constituted under Smart Grid Task Force and India Smart Grid Forum.CPRI is Chairman of the Working Group on Pilots and Trails in India under the India Smart Grid Task Force. It is also the Chairman of Working Group on Metering under India Smart Grid Forum, Chairman of ETD 13 of BIS on Energy Meter and member of several standardization groups.

1.6.5 Training

Following Workshop/Tutorial/conference were organized by CSET/IT&ID/UARC:

1. National Workshop on "Application of Information Technology to Power Systems" during 30–31 January, 2002.

2. National Workshop on "Communication Protocol for Power System Automation"during 22–23 January, 2004.

3. "Tutorial on International Electricity Metering Protocol (IEC-62056)" during 30 Nov. to 3 Dec., 2004 (Photo given at the bottom).

4. "International Workshop and Training on IEC-61850" during 25–28 April, 2006 (Photo given at the bottom).

5. National Workshop "On Knowledge Management System"during 19–20 April, 2007.

6. "One day Tutorial and two days National Conference on Distribution Automation"during 29–31 Oct, 2007.

7. International Conference on Roadmap for Smart Gridduring 3–4 August, 2011.

8. International Conference on Physical, Cyber and System Security of power sector during 27–28 Feb, 2012.

The laboratory is certified for ISO 9001:2008. CPRI is a member in DLMS UA (Device Language Message Specification User Association), Geneva. This test facility is accredited by Utility Communication Architecture International Users Group (UCA IUG) as Level - A which means

CPRI is an independent third party laboratory for testing of server devices for IEC 61850 compliance.

—— C E R T I F I E D ——
———— M E M B E R ————

1.7   PUBLICATIONS

The following are the papers/reports authored by the officers of Computer Division/CSET/IT&ID/UARC:

1.7.1   List of Publications

1. "CPRI Assembler" - Electronics for You, 1980 by Mr. R. Gavirangappa.

2. "Single – Pass Assembler for Microcomputer" - CSI, New Delhi, 1981 by Mr. R. Gavirangappa.

3. "Computer Aided Design of Resistor Banks in Power Apparatus Testing Stations" - BHEL, All India Seminar on Computers, 1986 by Mr. R. Gavirangappa.

4. "Engineering real-time simulator of the South Indian power system: Generalised description" - CESI-CPRI Workshop on long term R&D Cooperation, New Delhi, October, 1988 by Mr. R. Gavirangappa (Joint Authorship).

5. "Engineering real-time simulator of the South Indian power system: Models and Algorithms" - Middle East power system conference MEPCON, EGYPT, January, 1989 by Mr. R. Gavirangappa (Joint Authorship).

6. "Importance of Generation scheduling of thermal units for economic operation of power systems – Joint Authorship" - TENCON91, New Delhi, August, 1991 by Mr. R. Gavirangappa (Joint Authorship).

7. "Load Forecasting through different methods" - VII NPSC, Calcutta, 1993 by Mr. R. Gavirangappa.

8. "AMR and relevance of Interoperability at AMR / AMI seminar held by India Core (CPU) at New Delhi" - 25 April, 2008 by Mr. V. Shivakumar, E.O.Gr.3.

9. Smart Grid and Interoperability for Smart Grid Application" - National Conference on Smart Grid organized jointly by CDAC and IEEE at Thiruvananthapuram during 29–30 October, 2010. by Mr. M. Pradish, E.O.Gr.2.

10. "Testing Methodology for open protocol meter"- MI 2011 conference at New Delhi on 20–21 Jan, 2011. Mr. V. Suresh and Mr. V. Arunachalam are coauthors by Mr. M. Pradish, E.O.Gr.2.

11. "Communication Systems for Smart Grid." - Training Programme on Communication for Power Engineers at CPRI, Bangalore on 24 and 25 June, 2011 by Mr. V.Arunachalam, Additional Director.

12. "Mobile Communication Systems" - Training Programme on Communication for Power Engineers at CPRI, Bangalore on 24 and 25 June, 2011 by Mr. V.Shivakumar, E.O.Gr.3.

13. "Computer Communication System and Broadband over Power Line" - Training Programme on Communication for Power Engineers at CPRI, Bangalore on 24 and 25 June, 2011 by Mr. V.Shivakumar, E.O.Gr.3 and Mr. Ramadas, E.O.Gr.

14. "Satellite Communication System for Power Utility SCADA – A Case Study" - Training Programme on Communication for Power Engineers at CPRI, Bangalore on 24 and 25 June, 2011 by Mr. V. Shivakumar, E.O.Gr.3

15. "An approach to Smart Grid Pilot in India" - International Conference on Roadmap for Smart Grid at CPRI, Bangalore on 3 and 4 August, 2011, by Mr. V.Arunachalam, Additional Director and Mr. V.Shivakumar, E.O.Gr.3

16. "Interoperability and Standard for Smart Grid" - International Conference on Roadmap for Smart Grid at CPRI, Bangalore on 3 and 4 August, 2011 by Mr. V.Arunachalam, Additional Director and Mr. V.Shivakumar, E.O.Gr.3.

17. "IEC 61850 - The futuristic Automation Philosophy for substation." - Training program for BESCOM Engineers was conducted on 30.09.2011 at CPRI, Bangalore, by Mr. M. Pradish, E.O.Gr.2 and Mr. Mridula Jain, E.O.Gr.2.

18. "White Paper in SCADA in Power System Automation" Training program for BESCOM Engineers was conducted on 30.09.2011 at CPRI, Bangalore by Mr. Ramesh Patil, E.O.Gr.2.

19. "Interoperability and Standards for Smart Grid." - Training program on "Development of Smart Power Grids organized by Engineering Staff College of India Hyderabad during 18-20 Oct. 2011.by Mr. Shivakumar V, E.O.Gr.3.

20. "AMR/AMI and Smart Meters – The way forward." - Training program on "Development of Smart Power Grids organized by Engineering Staff College of India Hyderabad during 18-20 Oct. 2011.by Mr. V. Shivakumar, E.O.Gr.3.

21. "Communication Technologies for Smart Grid." - Training program on "Development of Smart Power Grids organized by Engineering Staff College of India Hyderabad during 18-20 Oct., 2011. by Mr. Shivakumar V, E.O.Gr.3 and Mr. V. Arunachalam, Additional Director.

22. "Distribution Automation and SCADA" - Training program for WBEDCL and coordinate visit to MCC of KPTCL. On 17.11.2011.by Mr. K.B.Manjunath, AD and Mr. Ramesh Patil, E.O.Gr.2.

TUTORIAL ON INTERNATIONAL ELECTRICITY METERING PROTOCOL ON 30-11-2004 TO 03-12-2004

23. "Substation Automation for the Smart Grid" - National Seminar on the theme Powering India by 2020: A Roadmap to Greener India jointly organized by The Institution of Engineers (India) West Bengal State Centre and CPRI on 25 to 27 Nov., 2011 by Mr. Ramesh Patil, E.O.Gr.3

24. "Smart Grid - The Indian Case Study" - IEEMA Journal, November, 2011 by Mr. V.Arunachalam, Additional Director, etal.

25. "Security Issues and Solutions for AMI/ AMR System" - International Conference on Physical, Cyber and System Security for Power Sector scheduled on 27 and 28 February, 2012 by Ms. Rajisha R, M.Tech Student and Ms. Shaileshwari M U, E.O.Gr.2

26. "Smart Grid Security Threats and Solutions " - International Conference on Physical, Cyber and System Security for Power Sector scheduled on 27 and 28 February, 2012 by Ms. Anju P Rajan Mathew, M.Tech StudentMs. Shaileshwari M.U, E.O.Gr.2.

27. "Indian Companion Specification- A Secured approach for Metering Protocol" - International Conference on Physical, Cyber and System Security for Power Sector scheduled on 27 and 28 February, 2012 by Ms. SowmyaBalla, JRF, Ms. ShaileshwariM.U., E.O.Gr.2,Mr. Arunachalam V, Additional Director andPradish M, E.O.Gr.2.

28. "Provision in Indian Companion Specification for DLMS Meters and Testing" - Published in one day workshop on Metering Standards – National and International Standards organized by ID and UARC on 05.03.2012 by Mr. V. Suresh, E.O.Gr.3 and Mr. V. Arunachalam, Additional Director.

1.7.2 List of Reports authored by Mr. R. Gavirangappa, Joint Director

1. "Voltage Gradient Calculation : Selection of conductor size and configuration for extra high voltage transmission lines – Developed computer programmes", CPRI, Bangalore, October, 1979 - Technical Report TR-91.

2. "Long Range Energy Demand Forecasting", CPRI, Bangalore, October, 1988-TR-177.

3. "South India power system load flow set up – Joint Authorship", CSEI, Bangalore, May, 1989.

4. "Unit Commitment In Power Systems", CPRI, Bangalore, March, 1990 - TR-196.

5. "Short Term Electrical Load Forecasting Methods", CPRI, Bangalore, December, 1991 - TR-243.

6. "South India electrical network engineering simulator: Description of main functions and of adopted mathematical", CSEI, Italy, 1989 Joint Authorship - CESI Technical Issue, 89–42.

7. "A design tool for distributed man-machine interface of real-time power systems and power plant simulators", CSEI, Italy, 1989 Joint Authorship - CESI Technical Issue, 89–42.

8. "Computer Aided Relay Co-Ordination",CPRI, Bangalore, 1998 - TR-330.

9. "Report On Macroscopic Planning In Power Systems",CPRI, Power System Division, April, 1993 - CPRI Internal Report.

10. "Computer Software For Short Term Load Forecasting – User Manual",CPRI, Central Research and Testing Laboratory, Power System Division, July, 1994 - CPRI Internal Report.

1.7.3 List of Student Projects Guided by Mr. R. Gavirangappa, Joint Director

1. Memory Optimized Loadflow And Hydro Thermal Scheduling – Project Report, Department of Electrical Engineering, University College of Engineering 1986.

2. A Comparative Study Of The Autoregressive Moving Average And Artificial Neural Network Methods In Short Term Load Forecasting, REC, Kerala, January, 1992.

3. Load Forecasting Using Discrete Kalman Filter, REC, Kerala, January, 1993.

4. Dynamic Simulation Of Hvdc Systems Using Fuzzy Logic Controller For Current Control, BMS College of Engineering, Bangalore, September, 1994.

5. Planning For Demand Side Management In The Electricity Sector – Report, Indira Gandhi Institute of Development Research, Bombay, 1994.

6. Maintenance of Budget Control Registers, PES College of Engineering, Mandya, August, 2001.

7. Medical Facilities For Employees In CPRI, Acharya Institute of Management and Sciences, Peenya, Bangalore – 58, December, 2001.

8. Searching Algorithms, A.P.S College of Engg, June, 2001

9. Computer Network Simulator, R.V. College of Engg., June, 2002.

10. Automation of Medical Reimbursement Scheme for Employees in CPRI, Sri. Siddhartha Institute of Technology, June, 2002.

11. Multicasting, Kalpatru institute of technology, Tiptur, May, 2002.

12. Knowledge Based Portal for Central Power Research Institute, Vivekananda Institute of Technology, Gudimavu, Kumbalagodu, Bangalore, June, 2005.

1.7.4 The list of Officers and Staff of UARC division in 2012 is given below:

1. Arunachalam V, Additional Director

2. Gavirangappa R, Joint Director

3. Ravikumar K, Joint Director

4. Shivakumar V, Engg. Officer Gr. 3

5. Suresh V, Engg. Officer Gr. 3

6. Pradish M, Engg. Officer Gr. 2

7. Mridula Jain, Engg. Officer Gr. 2

8. Ramesh Patil, Eng. Officer Gr. 2

9. Shaileshwari M U, Engg. Officer Gr. 2

10. Ramadas, Engg Officer Gr. 1

11. Elaveni M, Senior Assistant

12. Ramachandra M, Attendant Gr. 2

13. Ravi N, SafaiwalaGr. 2