

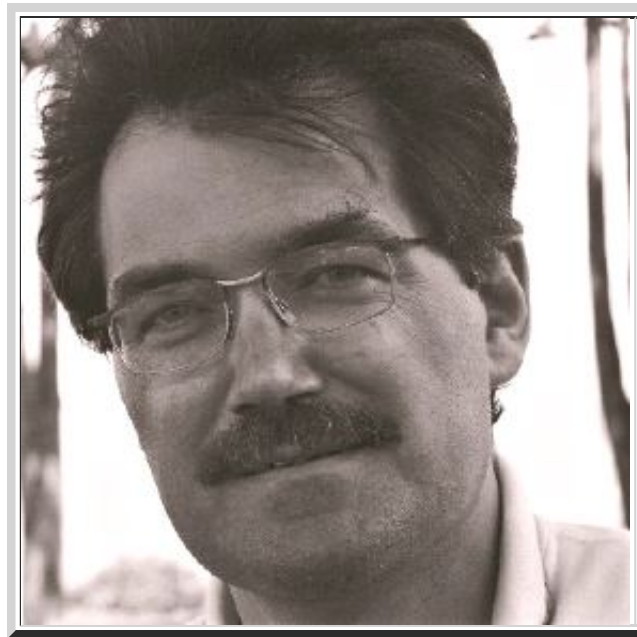
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Cellular Networking Perspectives Ltd.

Résumé for David Crowe

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David Crowe is a well known wireless network standards and numbering resource consultant who has succeeded with many technical and leadership responsibilities over almost 30 years. He has consulted for a number of major telecom corporations and startups since 1992 and before that was employed as a real-time software designer and manager in computer and communications applications.

David has extensive experience in the development and implementation of wireless telecom standards, telecom protocols and also in real-time software development, particularly software related to wireless telecommunications. He is a well known [writer](#) on wireless technology and standards. From 1992 to 2004 David was editor of *Cellular Networking Perspectives* and publisher of *Wireless Security Perspectives*. His combination of written communication skills, technical expertise and industry experience are unique.

David is an excellent resource for strategic advice for wireless communications projects, melding his vast technical, numbering resource and standards experience with his understanding of the increasing importance of the political and social environment influencing the adoption and success of wireless initiatives. His experience is also invaluable in legal cases.

Items shown in [green](#) are ongoing responsibilities or current capabilities. Items shown in [red](#) are recent additions.

Availability:

David is available for limited amounts of highly focused consulting and speaking engagements. Consulting rates vary depending on the type and duration of consulting. Inquire for details.

Chronological List of Assignments, Activities & Achievements

Category	Details
Expertise	<ul style="list-style-type: none"> ● Analysis of patents involving wireless communications. ● Review of system designs with a wireless

	<p>component.</p> <ul style="list-style-type: none"> • Numbering resource management issues. • International roaming issues. • Government telecommunications mandates including Emergency Services (9-1-1), Surveillance, Number Portability and Priority Calling. • Preparation of documents with legal/technical overlap. • Expert witness in criminal or civil cases involving wireless network or numbering resource management issues. • Preparation of white papers for a general or specialist audience. • Editing of technical documents that require a particularly high level of clarity and technical accuracy. • Acting as a representative on a wireless standards or other specification development committees. • Educator or presenter on complex technical issues. • Wireless mobility standards and protocols (including ANSI-41 and GSM MAP) • AJAX web programming using html, javascript, css, mySQL, FileMaker and PHP. • Software development using C, Javascript, PHP, FileMaker, AppleScript.
<p>Current Positions</p>	<ul style="list-style-type: none"> • Editor of TIA TSB-29/3GPP N.S0017 (International Implementation of Wireless Telecommunications Systems Compliant with TIA/EIA-41) • Administrator for International Roaming MIN (IRM) network identifier codes to carriers and SID (System Identification) code ranges to countries on behalf of IFAST. • Member of the Board of Directors of IFAST. • Recognized as a technical expert in District Court in Chicago in a Motorola/Huawei lawsuit in January, 2011. • Recognized as an expert witness in telecom by a Maryland Circuit Court during an Iraqi-US civil dispute (2009). • Recognized as a "forensic expert in the field of wireless technology" by Ontario Superior Court (2003).

Major Accomplishments

- Developer of number management and customer invoicing database for **IFAST** (FileMaker).
- Extensive expertise using Adobe applications FrameMaker and Acrobat.
- Extensive database design and implementation experience using Oracle, SQL and FileMaker.
- High level of expertise in the programming languages C, AppleScript, JavaScript, PHP and FileMaker.
- Editor of a number of major wireless industry standards.
- Author of a number of reports on industry issues for both proprietary and public audiences.
- A prolific writer of technical articles about wireless communications and standards for a general audience both for his own newsletters (1992-2004) and for wireless industry magazines (1994-2009).
- Lead developer of network standards to support wireless Emergency Services (e.g. **9-1-1**) and International Roaming.
- Major contributor to wireless network standards for number portability, fraud prevention, **PSTN** interconnection and network authentication protocols.
- Co-founder of **IFAST** in 1996.
- Co-developer of standards and guidelines for the management of several wireless numbering resources **MIN** (and **IRM**), **ESN**, **IMSI**, **SID**, **MEID** and **EUIMID**.
- A lead developer of the **ANSI-41** mobility management standards.
- Familiar with every aspect of telecom and computer protocols from conception and design through standardization and implementation.
- Lead technical expert of a **CDG** initiative to encourage the completion of the **MEID/EUIMID** transition (from **ES** and **UIMID**).
- Chairman of several **TIA** and **3GPP2** standards committees, Joint Expert Meetings and working groups.
- Consultant to major wireless corporations and trade associations.
- Chairman of a 3GPP2 Steering Committee ad hoc that produced a report on numbering resources for

	M2M, SC.R4005.
2014	<ul style="list-style-type: none"> • Edited all technical changes for 3GPP2 C.S0073 (MEID Conformance Testing) and CDMA Card Application Toolkit (CCAT; C.S0035). • Technical consultant to Qualcomm in the area of wireless standards and numbering resource management from 2002 to 2014. • Chair of TIA TR-45.5 Working Group 1 (publication of standards for cdma2000 smart cards, provisioning, voice coders and location-based services) from 2012 to 2014. • 3GPP2 editor for the R-UIM (C.S0023), CSIM (C.S0065) Smart Card, CCAT (CDMA Card Application Toolkit) and USSD Service Option (C.S0105) specifications. • Appointed editor of TIA TSB-29/3GPP N.S0017 (International Implementation of Wireless Telecommunications Systems Compliant with TIA/EIA-41) • Technical consultant to CDG in the areas of the MEID and EUIMID transition, M2M and numbering issues from 2008 to 2014. • Completed publication of the updated CSIM specification, C.S0065-B v3.0 • Edited technical content for the 3GPP2 Location Based Service specifications C.S0022 and C.R0022
2013	<ul style="list-style-type: none"> • Organized successful 3GPP2 technology webinar • Editor of revised USSD air interface standards for 3GPP2 C.S0105-A • Editor of revised standard for MEID and EIR, X.S0008-A • Speaker at CDG GHRC meeting in Beijing on Dual-IMSI devices and 3GPP2 standards • Implemented live web-based queries for IFAST IRM and SID databases, and for several non-profit clients • Appointed editor of 3GPP2 C.S0073 (MEID Conformance testing)
2012	<ul style="list-style-type: none"> • Chairman of cdma2000 technology workshop in

	<p>Guangzhou, China, sponsored by 3GPP2.</p> <ul style="list-style-type: none"> • Editing of CDMA Card Application Toolkit (CCAT) specification update to V&V (C.S0035-A v3.0) • Editor of initial USSD air interface support for cdma2000 C.S0105 • Appointed chair of TIA TR-45.5 Working Group 1 (TIA standards for cdma2000 cards, provisioning and location services)
<p>2011</p>	<ul style="list-style-type: none"> • Completion of a major CSIM bug fix release 3GPP2 C.S0065-B v2.0. • Appointed editor of CDMA Card Application Toolkit (CCAT) specification 3GPP2 C.S0035. • Speaker at CDG DSC meeting on IPv6. • Expert witness testifying in Chicago-based intellectual property dispute between major telecom manufacturers. • Presentation for CDG Africa Forum in Lagos, Nigeria • Appointed chair of the 3GPP2 ad hoc workshop committee to plan an industry workshop on CDMA2000 for 2012. • Led 3GPP2 Steering Committee ad hoc on M2M Numbering through completion of report, 3GPP2 SC.R4005 and publication by TIA. • Edited a major bug fix release (about 500 changes) for the R-UIM card specification C.S0023-D v2.0 through to publication. • Interactive web-based database access project for non-profit client using AJAX techniques. • Received certificate of appreciation from ARIB, TTA, TTC, CCSA and TIA (3GPP2 Steering Committee): "A key contributor, most notably as Chair of the SC M2M Numbering Ad-hoc Group and Chair of the workshop Planning Ad-Hoc Group. Your leadership is admirable and serves as a foundation to the continued success of the organization. In addition, your vision is invaluable."
<p>2010</p>	<ul style="list-style-type: none"> • Developed revisions to US IMSI guidelines to support Public Safety LTE networks and MVNOs.

	<ul style="list-style-type: none"> • Discussions with CDMA2000 operators in China, Morocco, Indonesia, Thailand, Malaysia, Vietnam, Philippines and elsewhere. • Participated in revisions to MEID/SF_EUIMID, UIMID and ESN guidelines. • Discussions with handset manufacturers in China and Canada regarding MEID and EUIMID issues. • Survey of R-UIM card vendor preparedness for EUIMID. • Editor of new point releases for 3GPP2 specifications C.S0023 (R-UIM cards) and C.S0065 (CSIM cards). • Submitted C.S0065-B v2.0 for V&V and TIA ballot. • Received Award of Merit from 3GPP2 TSG-C for activities in Working Group 1. • Appointed chair of the 3GPP2 ad hoc on Machine-to-Machine numbering. • Modifications to CDMA2000 Global Handset Requirements document to support MEID and EUIMID and presentation at a CDG meeting leading to acceptance.
<p>2009</p>	<ul style="list-style-type: none"> • Lead technical consultant for the CDG on the MEID/EUIMID transition. • Developer of an eLearning course on the MEID/EUIMID transition. • Featured speaker at a numbering forum sponsored by the TIA in Mumbai. • Representative of the CDG at joint meetings with the TIA and China Telecom, Samsung, Qualcomm, LG Electronics, KT Freetel, ZTE, Huawei and four Nigerian operators. • Representative of the CDG in meetings with the TR-45 EUMAG, 3GPP2 TSG-S Numbering Working Group 1 and other numbering forums. • Appointed editor of 3GPP2 C.S0023 (Removal UIM) and C.S0065 (CSIM). • Consultant for CDG on OMH 'smart card' standardization. Contributions to the project recognized by Qualcomm in November, 2009. • Expert witness for two court cases. Recognized as an expert in telecom by a Maryland Circuit Court judge and expert report submitted.

<p>2008</p>	<ul style="list-style-type: none"> • Speaker on numbering and identification issues related to international roaming at a CDG IRT meeting in Vancouver, Canada. • Speaker on a CDG (CDMA Development Group) webinar on MEID and EUIMID. • Speaker on a Rural Cellular Association webinar on the MEID and EUIMID transition. • Gave presentations on technical issues related to the MEID and EUIMID transition to two US-based telecom infrastructure manufacturers. • Articles on Removable UIM cards and user interfaces for Wireless Telecom magazine.
<p>2007</p>	<ul style="list-style-type: none"> • Author of a declaration submitted to the FCC as part of the CTIA comments on a US Department of Justice petition for expedited rulemaking on packet data support under the CALEA legislation. • Consultant on several wireless patent issues (further information cannot be provided due to confidentiality requirements). • Consultant to Qualcomm/CDG on issues related to the implementation of MEID (replacement for ESN) and EUIMID (replacement for UIMID) including detailed presentations to a number of carriers in Asia. For more information on the package of information that David developed see cdg.org/meid. • Co-author of a report on the use of wireless communications for utility data transmissions.
<p>2006</p>	<ul style="list-style-type: none"> • Received Certificate of Appreciation from chair of 3GPP2 TSG-X • Received Certificate of Appreciation from Matt Flanigan, President of TIA • Completed a two year term as chair of TIA TR-45.2. • Completed more than three years as chair of 3GPP2 TSG-X ERA working group (Evolution, Requirements and Architecture).
<p>2005</p>	<ul style="list-style-type: none"> • Completed editing of 3GPP2 documents X.S0006 (AKA) and X.S0008 (MEID) through to ballot and publication for both 3GPP2 and TIA.

	<ul style="list-style-type: none"> • Resolution of a dispute between TIA subcommittees TR-45.2 and TR-45.6 over responsibility for US lawfully authorized electronic surveillance standards. • Completion of J-STD-036 Revision B (published in June 2005). • Completion of an addendum to 3GPP2 X.S0008 to define the decimal representation for MEID. • Drafted modifications to the IFAST SID assignment guidelines to allow national assignment by IFAST.
<p>2004</p>	<ul style="list-style-type: none"> • Prepared a report on the use of wireless phones as part of the Emergency Alert Service for the Rural Cellular Association which was included as part of their submission to the FCC. • Elected chair of TIA subcommittee TR-45.2 (effective September 2004) on the third ballot following two ties. • Developer of a presentation on the MEID (Mobile Equipment ID) for the TIA TR-45 ad hoc group on Equipment Identification now published on the TIA Equipment ID website. • Writer for Network Cabling magazine • Completed editing of joint TIA/ATIS standard for GSM/ANSI-41 Interworking: J-STD-038 Revision B (CDMA support) which was published in October 2004. • Completed editing of 3GPP2 X.P0008 standard for MEID. • Editor of Cellular Networking Perspectives from 1992 through 2004 and Wireless Security Perspectives from 1999 through 2004.
<p>2003</p>	<ul style="list-style-type: none"> • Approved as a forensic expert in the field of wireless technology for the Ontario (Canada) Superior Court. • Editor of J-STD-036 Revision B to incorporate field experience with enhanced 911 and provide enhanced GSM emergency services capabilities (interim position). • Editor of 3GPP2 X.P0008 on MEID (Mobile Equipment Identification). • Development of standards for location services

	<p>(LCS) for both commercial and emergency purposes.</p> <ul style="list-style-type: none"> • For Telcordia developed a SID management proposal for the FCC. • Appointed chair of 3GPP2 TSG-X ERA working group (Evolution, Requirements and Architecture).
2002	<ul style="list-style-type: none"> • Invited speaker at the Second Symposium for CDMA Global Roaming in Seoul. • Acting chair of the TIA TR-45.2 ad hoc group on Emergency Services. • Edited the wireless industry Enhanced 911 specification $\text{J-ST}\text{D-036-A}$ through to publication. • Articles on Wireless Security, m-commerce, Short Message Service Interoperability and IP versus SS7 for Wireless Telecom magazine. • Author of an internal report on international roaming for a major wireless equipment vendor. • Elected chairman of TR-45.2/TSG Working Group I on Service Descriptions (Stage I) by acclamation.
2001	<ul style="list-style-type: none"> • Appointed vice-chairman of 3GPP2 TSG-N/TIA TR-45.2 Working Group I on service descriptions. • Speaker at CITO (Communications and Information Technology Ontario) conference in Ottawa. • Appointed to Advisory Board of Wmode. • Content provider for the CDG website. • Editor of ongoing enhancements (Addendum 2) to Emergency Services Phase II Network Standard (JSTD036). • Appointed as International SID (System Identification) number administrator by IFAST.
2000	<ul style="list-style-type: none"> • Invited speaker and panelist at IIR Wireless Internet Forum in Toronto. • Appointed Contributing Editor for Wireless Review magazine. Articles written on topics such as Wireless Markup Language (WML), Wireline

	<p>Replacement, Emergency Services (911), Numbering, Authentication, Network Reliability and Security.</p> <ul style="list-style-type: none"> • Regular columnist for Canadian Wireless Telecommunications Association (CWTA) magazine Wireless Telecom. Articles published include Numbering Conservation, Calling Party Pays (CPP), Wireless Application Protocol (WAP) and Bluetooth. • Managing IFAST International Roaming MIN (IRM) assignments. • Consultant to other wireless equipment manufacturers. • Writer and editor of Cellular Networking Perspectives. • Publisher and editor of Wireless Security Perspectives. • Invited speaker on International Roaming MINs at CTIA Wireless Partners conference. • Editor of Emergency Services Phase II Network Standard (J-STD-036). • Editor of the TR-45.2 3G enhanced authentication standard.
<p>1999</p>	<ul style="list-style-type: none"> • Founded Wireless Security Perspectives • Appointed representative for AT&T Wireless on the TIA TR-45.2 standards subcommittee • Invited speaker Wireless Partners conference in Miami sponsored by Cibernet and the CTIA • Invited speaker at the GTE conference Global Roaming Resolving Technical and Business International Roaming Issues in Washington, DC. • Author of feature article in Wireless Review magazine on the impact of advances in SS7 technology on wireless telecommunications systems. • Monthly columnist in the bimonthly Wireless Review magazine (successor to Cellular Business) covering 3G Systems; Location Technology; International Roaming; Numbering Issues; WAP; Beyond SS7; Billing and more. • Scheduled speaker Institute for International Research (IIR) conference on Calling Party Pays/Local Number Portability in New Orleans. • Representative on TIA Standards Subcommittee

	TR-45.2
1998	<ul style="list-style-type: none"> • Monthly columnist in the bimonthly Wireless Review magazine (successor to Cellular Business) with articles on Wireless radio advances; Authentication; Future of SS7; Electronic Surveillance (CALEA); IS-124 for call detail/billing records; Wireless Data; Calling Party Pays; Local Number Portability; International Roaming Problems; Wireless Intelligent Network (WIN); Opportunities with Gateway MSCs. • Content provider for IFAST and CTIA web sites. • Feature article on planned Australian AMPS closure in Cellular & Mobile International magazine • Leadership of effort to complete the internationalization of the TIA/EIA-41 standard for intersystem operations (IS-807). • Consultant to CTIA regarding the US IMSI Management Council • Author of IFAST SID Assignment Guidelines.
1997	<ul style="list-style-type: none"> • Guest columnist in Cellular Business PCS'97 Show Dailies with an article on third generation wireless systems. • Leadership of successful effort to publish Revision B of TSB-29 (as chair of TIA TR-45.2 WG VI) providing recommendations for international applications of IS-41 based systems. • Leadership of effort to publish IS-751 (as chair of TIA TR-45.2 WG VI) providing support for IMSI (International Mobile Station Identity) in IS-41. • Consultant to CTIA regarding the IMSI Management Council (now the IMSI Oversight Council) and Calling Party Pays (CPP). • Completed the first MIN Assignment Guidelines. Now updated and used by the MBI Assignment Authority. • Consultant to other wireless equipment manufacturers.
1996	<ul style="list-style-type: none"> • Monthly columnist in Cellular Business

	<ul style="list-style-type: none"> • Moderator and speaker for Wireless World '96 panel on Analog vs. Digital Features. • Liaison between International Forum on AMPS Standards Technology (IFAST) and TIA standards committee TR-45.2 (on behalf of Alcatel). • Author of CTIA reports on the Open Wireless Network Architecture and A National Authentication Center. • Certificate of Appreciation from TIA In appreciation of your personal efforts and dedication in the development of TIA/EIA IS-41-C. • Speaker on IS-41 Rev. C at CTIA Wireless '96 session Incumbency 101. • Speaker on TSB-29 at International Forum on AMPS Standards Technology (IFAST). • Article on border cell problems published in Wireless'96 Cellular Business Show Dailies. • Feature article on the IS-124 call detail record standard published in Wireless'96 Cellular Business Show Dailies. • Guest speaker for Natural Microsystems at a customer function associated with Wireless'96.
<p>1995</p>	<ul style="list-style-type: none"> • Co-Founder of IFAST (International Forum on AMPS Standards Technology). • Speaker on international issues at CTIA/PCIA sponsored Wireless Interconnect Forum. • Speaker on IS-41 at Universal Wireless Communications conference in Cancun. • Speaker on seamless network standards at SPIE conference. • Speaker on wireless 9-1-1 standards development at SPIE conference. • Columnist for Cellular Integration (previously Cellular Marketing) magazine. • Speaker on international roaming and priority access at Bellcore WIF. • Guest speaker at the first Excel Inc. user's conference.
<p>1994</p>	<ul style="list-style-type: none"> • Appointed chair of TIA subcommittee TR-45.2 Working Group VI on international issues. • Chair of TIA International Roaming Joint Expert's

	<p>Meeting that led to the replacement of MIN by IMSI as the future AMPS mobile identification.</p> <ul style="list-style-type: none"> • Speaker at CTIA forum on Extension Phone Service. • Panelist at IEEE ICUPC conference. • Panelist at CTIA forum on Commercial Mobile Radio Services.
<p>1993</p>	<ul style="list-style-type: none"> • Panelist at Cellular Business convention Wireless World'93. • Presenter at CTIA forum on Authentication. • Editor of TIA Border Cell Standard TSB-65 (later incorporated in TIA/EIA/IS-41 Revision C).
<p>1992</p>	<ul style="list-style-type: none"> • Contracted to represent Alcatel on the TIA TR-45.2 standards subcommittee. • Founded the Cellular Networking Perspectives technical bulletin. • Appointed editor of the IS-41 test plan standard (TIA/EIA/TSB-56).
<p>NovAtel Communications 1984–1992</p>	<ul style="list-style-type: none"> • Representing NovAtel on TIA TR-45.2 standards subcommittee. • Manager of cellular switching software development. • Designer of call processing kernel and common channel signaling (in C on RSX and Unix operating systems). • Designer of a protocol for a pre-ANSI-41 mobility management system • IS-41 Rev. 0 field trial team leader • Designer of call detail record format and collection software (in C on VMS Operating System). Negotiated support for the format with CBIS (Cincinnati Bell Information Systems) the major billing system provider at that time. • Designer of real-time and software development software tools (in C on RSX) • Published a paper on CPU Probes (a software analyzer of software performance) • Oracle Training (API programming and optimization) • Base Station to MSC data link design (for

	<p>redundancy options)</p> <ul style="list-style-type: none"> • Maintenance of schedules for each SMC revision (including hardware). • Canada Award for Business Excellence (Bronze in innovation category) for SMC product
<p>Sentrol Systems (now Valmet Automation) 1981-1984</p>	<ul style="list-style-type: none"> • Realtime software development in C • Designer and implementer of a realtime hypertext system for customer created realtime interconnected displays. • Customer configurable emergency shutdown for Home Oil pipeline. • Dual-Standby redundancy software • WYSIWYG editor for creation of customer monitoring screens
<p>Glenayre Electronics, Vancouver 1980-1981</p>	<ul style="list-style-type: none"> • Real-time software development for transportation systems. • Software tools and extensions to MP/M operating system.
<p>University of British Columbia (UBC) 1978-1980</p>	<ul style="list-style-type: none"> • Development of a data entry and retrieval system for the university's herbarium. • Studies in Botany • Publication of Agamospermy and Hybridization in Bidens in Northwestern Ontario in the journal <i>Taxon</i> • Development of true-perspective 3-dimensional software to illustrate biosystematic data reductions from many dimensions to 2 or 3 dimensions. • Development of Principle Coordinates Analysis data reduction software • COBOL certification
<p>Lakehead University 1974-1978</p>	<ul style="list-style-type: none"> • HBS degree in Biology/Mathematics (First Class Honours) with thesis containing extensive and innovative computer analysis of botanical data. • Gold Medal for Science Faculty (ex aequo). • Biology Department Prize. • Recipient of NSERC (Canadian National Science and Engineering Research Council) graduate

studies full scholarship.

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