Using Cortina Calendar API

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There is an API to work with Cortina (Polopoly) for calendar entries. This document describes some experiments with tis API. These experiments were done via the endpoint:

<https://api-r.referens.sys.kth.se/api/cortina/swagger/?url=/api/cortina/swagger.json>

# Introduction to graphql in Canvas

Listing 1‑1 shows a simple query to the /api/cortina/\_checkAPIkey endpoint to check the API key.

Listing ‑: Example of a call to check the API key

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| <https://api-r.referens.sys.kth.se/api/cortina/_checkAPIkey>  **code** 200  **Response headers:**  content-length: 0  date: Sat, 24 Aug 2019 10:27:43 GMT  x-powered-by: Express  referrer-policy: origin-when-cross-origin  strict-transport-security: max-age=31536000  **Response body:**  An empty response |

To deal with the calendars you need to know the department ID. You can find this using the endpoint shown in Listing 1‑2. In this figure we can see information about the acronym for the school (['ABE', 'EECS', 'ITM', 'CBH', 'SCI']) and for the department within the school. It also has the type of seminar, which is one of ['dissertation', 'licentiate', 'thesis']. The response is shown in

Listing 1‑3.

Listing ‑: GET /findCalendarDepartmentId

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| https://api-r.referens.sys.kth.se/api/cortina/findCalendarDepartmentId?seminarType=dissertation&schoolName=EECS&departmentName=ISE |

Listing ‑: Reponse to above query

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| **Response code:** 200  **Response headers:**  content-length: 23  content-type: application/json; charset=utf-8  date: Sat, 24 Aug 2019 10:35:25 GMT  etag: W/"17-bhkSjZXr0zsuU4SzhCWcn48RbhM"  x-powered-by: Express  referrer-policy: origin-when-cross-origin  strict-transport-security: max-age=31536000  **Response body:**  {  "contentId": "2.86514"  } |

We can now get the calendar events of the selected type fothe the indicated department with /v1/calendarlist/{contentId} the response is shown in Listing 1‑4

Listing ‑: Output from GET of https://api-r.referens.sys.kth.se/api/cortina/v1/calendarlist/2.86514

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| **Code** 200  **Response body:**  [  {  "contentId": "1.870302",  "inputTemplate": "it.article.calendarevent",  "contentName": "Characterisation, Modelling and Digital Pre-distortion Techniques for RF Transmitters in Wireless Systems ",  "advisor": "Professor Peter Händel",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-02-18T12:00:00.000Z",  "defaultLocale": true,  "externalId": "",  "lead": "",  "lecturer": "",  "locale": "sv\_SE",  "location": "Hörsal 99131; University of Gävle",  "locationUrl": "",  "opponent": "Professor Noureddine Boulejfen, Research Center for Microelectronics and Nanotechnology, Technopole de Sousse, Sousse, Tunisia ",  "parentId": "2.86514",  "respondent": "Mahmoud Alizadeh",  "respondentUrl": "",  "respondentDepartment": "Teknisk informationsvetenskap",  "seminartype": "dissertation",  "subjectarea": "Elektro- och systemteknik",  "paragraphs\_text": "",  "translations": [  "1.870304"  ],  "uriContentId": "",  "uri": ""  },  {  "contentId": "1.876901",  "inputTemplate": "it.article.calendarevent",  "contentName": "Performance Trade-offs for Ultra-Reliable Low-Latency Communication Systems",  "advisor": "Associate professor James Gross, Teknisk informationsvetenskap; Professor Mikael Skoglund, Teknisk informationsvetenskap",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-06-14T08:00:00.000Z",  "defaultLocale": true,  "externalId": "diva2:1316410",  "lead": "",  "lecturer": "",  "locale": "en\_UK",  "location": "F3, Lindstedtsvägen 26, Stockholm (English)",  "locationUrl": "https://www-r.referens.sys.kth.se/places/room/id/2b863516-4a75-4c89-94dd-03faf8e9258f",  "opponent": "Professor Cenk Gursoy, Syracuse University",  "parentId": "2.86514",  "respondent": "Sebastian Schiessl",  "respondentUrl": "https://www.kth.se/profile/schiessl",  "respondentDepartment": "Teknisk informationsvetenskap",  "seminartype": "dissertation",  "subjectarea": "Electrical Engineering",  "paragraphs\_text": "<h2>Abstract</h2> \n<p>In this dissertation, we consider wireless systems for ultra-reliable low-latency communication (URLLC). URLLC systems are required for example in industrial closed loop control systems, where data must be transmitted within a short target delay of at most a few milliseconds. Violations of this deadline could result in costly failures, and should therefore occur only with very low probability, with target violation probabilities of 10<sup>-8</sup> and below.This presents a number of novel challenges from a research perspective. First of all, the wireless channel is changing over time due to fading. When the system cannot exploit diversity to mitigate the effects of fading in each transmission attempt, then the transmitter may need to adapt the rate of the channel code to the current channel state in order to reduce the probability of transmission errors. However, time-varying data rates and transmission errors lead to a random queueing delay of the data, which may exceed the maximum delay that is tolerated by the application. In order to ensure that violations of the deadline occur only with very small probability, the evaluation of the system performance must therefore take this queueing delay into account. Second, many traditional performance models for the physical layer of wireless communication systems do not hold when the communication latency is short. For example, many previous works in wireless communications assume that by using channel coding, one can achieve error-free communication at the channel capacity. This model is no longer accurate when the blocklength of the channel code is very short, as it is the case in URLLC systems. Another assumption that becomes invalid at very short latency is that the transmitter can perfectly estimate the current state of the channel. With only few resources available for channel estimation, it will not be possible to obtain accurate channel state information (CSI). Thus, the transmitter cannot perfectly adapt the coding rate to the current channel state, which will result in transmission errors. In this dissertation, we apply stochastic network calculus to analyze the queueing delay of the system, while using realistic models of the physical layer transmissions that take imperfect CSI and finite blocklength effects into account. We then investigate three different types of systems. First, we consider a single-antenna system and consider the effects of channel coding at finite blocklength, as well as imperfect CSI. One of the main challenges in this context is that no closed-form expression for the joint decoding error probability due to channel coding at finite blocklength and due to imperfect CSI exists, so that higher-layer performance analysis remains infeasible. We solve this challenge by combining recent results from information theory on finite-length coding with an approximation for the estimation uncertainty due to imperfect CSI, which allows us to derive a closed-form approximation for the resulting joint decoding error probability. This expression can then be used to find the optimal rate adaptation scheme with respect to the delay performance, i.e., the optimal trade-off between the selected coding rate and the resulting error probability. We use these results also to determine the optimal training sequence length, i.e., the optimal trade-off between the time spent on channel estimation and the time remaining for the actual data transmission. Second, we consider downlink transmissions in a multi-antenna systems with multiple users. Specifically, we consider MISO (multiple-input single-output) systems, which means that a transmitter with multiple antennas can transmit data to several users that have a single antenna each. If the transmitter has perfect CSI, it can apply beamforming and send data simultaneously to multiple users, without the signal sent towards one receiver creating any interference at the other receivers. However, with imperfect CSI, the beamforming is imperfect, resulting in substantial interference between the signals for the different users, which can again lead to decoding errors. We derive closed-form approximations for the error probability due to this interference, and apply our previous results to take also the finite blocklength effects into account. Interestingly, although we observe a substantial quantitative performance loss due to imperfect CSI, the qualitative behavior and the optimal number of simultaneously scheduled users remains very similar.Third, we consider a system that uses non-orthogonal multiple access (NOMA) in the uplink. In the NOMA uplink, two devices may access the channel at the same time, mutually interfering with each other. Fortunately, the interference of one of the users can be mitigated by applying successive interference cancellation (SIC). However, when the chosen transmission rates are selected based on imperfect CSI, the decoding of one or both users can fail. We provide closed-form approximations for the decoding error probabilities for both SIC and a more general joint decoding scheme. Furthermore, we also take the effects of finite blocklength coding into account. The error probability for each user depends on the rates chosen for both users, and we determine the optimal trade-off between both rates such that the delay performance of both users is optimized. Nevertheless, we find that in delay-limited systems with realistic system assumptions, NOMA may result in lower performance than orthogonal access, even with optimized system parameters.</p> \n",  "translations": [  "1.876931"  ],  "uriContentId": "1.877030",  "uri": "http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-251650"  },  {  "contentId": "1.877112",  "inputTemplate": "it.article.calendarevent",  "contentName": "Characterisation, Modelling and Digital Pre-DistortionTechniques for RF Transmitters in Wireless Systems",  "advisor": "Professor Peter Händel, Teknisk informationsvetenskap; Professor Daniel Rönnow, University of Gävle",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-02-18T12:00:00.000Z",  "defaultLocale": true,  "externalId": "diva2:1278108",  "lead": "",  "lecturer": "",  "locale": "en\_UK",  "location": "Hörsal 99131, University of Gävle, Kungsbäcksvägen 47, SE-80176, Gävle (English)",  "locationUrl": "",  "opponent": "Professor Noureddine Boulejfen, Research Center for Microelectronics and Nanotechnology, Technopole Sousse, Tunisia",  "parentId": "2.86514",  "respondent": "Mahmoud Alizadeh",  "respondentUrl": "",  "respondentDepartment": "Teknisk informationsvetenskap, University of Gävle",  "seminartype": "dissertation",  "subjectarea": "Electrical Engineering",  "paragraphs\_text": "<h2>Abstract</h2> \n<p>Wireless systems have become an inevitable part of modern technologies serving humankind. The rapid growth towards large dimensional systems, e.g. 5th generation (5G) technologies, incurs needs for improving the performance of the systems and considering aspects to make them as far as possible environmentally friendly in terms of power efficiency, cost, and so on. One of the key parts of every wireless communication system is the radio frequency (RF) power amplifier (PA), which consumes the largest percentage of the total energy. Hence, accurate models of RF PAs can be used to optimize their design and to compensate for signal distortions. This thesis starts with two methods for frequency-domain characterisation to analyse the dynamic behaviour of PAs in 3rd-order non-linear systems. Firstly, two-tone signals superimposed on large-signals are used to analyse the frequency-domain symmetry properties of inter-modulation (IM) distortions and Volterra kernels in different dynamic regions of RF PAs in a single-input single-output (SISO) system. Secondly, three-tone signals are used to characterise the 3rd-order self- and cross-Volterra kernels of RF PAs in a 3 × 3 multiple-input multiple-output&nbsp;(MIMO) system. The main block structures of the models are determined by analysing the frequency-domain symmetry properties of the Volterra kernels in different three-dimensional (3D) frequency spaces. This approach significantly simplifies the structure of the 3rd-order non-linear MIMO model.</p> \n<p>The following parts of the thesis investigate techniques for behavioural modelling and linearising RF PAs. A piece-wise modelling technique is proposed to characterise the dynamic behaviour and to mitigate the impairments of non-linear RF PAs at different operating points (regions). A set of thresholds decompose the input signal into several sub-signals that drive the RF PAs at different operating points. At each operating point, the PAs are modelled by one sub-model, and hence, the complete model consists of several sub-models. The proposed technique reduces the model errors compared to conventional piece-wise modelling techniques.</p> \n<p>A block structure modelling technique is proposed for RF PAs in a MIMO system based on the results of the three-tone characterisation technique. The main structures of the 3rd- and higher-order systems are formulated based on the frequency dependence of each block. Hence, the model can describe more relevant interconnections between the inputs and outputs than conventional polynomial-type models.</p> \n<p>This thesis studies the behavioural modelling and compensation techniques in both the time and the frequency domains for RF PAs in a 3 × 3MIMO system. The 3D time-domain technique is an extension of conventional 2D generalised memory polynomial (GMP) techniques. To reduce the computational complexity, a frequency-domain technique is proposed that is efficient and feasible for systems with long memory effects. In this technique, the parameters of the model are estimated within narrow sub-bands. Each sub-band requires only a few parameters, and hence the size of the model for each sub-band is reduced.</p> \n",  "translations": [  "1.877239"  ],  "uriContentId": "1.877113",  "uri": "http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-241126"  },  {  "contentId": "1.877321",  "inputTemplate": "it.article.calendarevent",  "contentName": "Optimal Transmit Strategies for Multi-antenna Systems with Joint Sum and Per-antenna Power Constraints",  "advisor": "Professor Tobias Oechtering, Teknisk informationsvetenskap; Professor Skoglund Mikael, Teknisk informationsvetenskap",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-04-26T11:30:00.000Z",  "defaultLocale": true,  "externalId": "diva2:1300866",  "lead": "",  "lecturer": "",  "locale": "en\_UK",  "location": "Kollegiesalen, Brinellvagen 8, Stockholm (English)",  "locationUrl": "https://www-r.referens.sys.kth.se/places/room/id/dec1b09f-cf92-4a13-a71c-fae5bec331e1",  "opponent": "Dr. Martin Schubert, Huawei Technologies",  "parentId": "2.86514",  "respondent": "Le Phuong Cao",  "respondentUrl": "https://www.kth.se/profile/plcao",  "respondentDepartment": "Teknisk informationsvetenskap",  "seminartype": "dissertation",  "subjectarea": "Electrical Engineering",  "paragraphs\_text": "<h2>Abstract</h2> \n<p>Nowadays, wireless communications have become an essential part of our daily life. During the last decade, both the number of users and their demands for wireless data have tremendously increased. Multi-antenna communication is a promising solution to meet this ever-growing traffic demands. In this dissertation, we study the optimal transmit strategies for multi-antenna systems with advanced power constraints, in particular joint sum and per-antenna power constraints. We focus on three different models including multi-antenna point-to-point channels, wiretap channels and massive multiple-input multiple-output (MIMO) setups. The solutions are provided either in closed-form or efficient iterative algorithms, which are ready to be implemented in practical systems.</p> \n<p>The first part is concerned with the optimal transmit strategies for point-to-point multiple-input single-output (MISO) and multiple-input multiple-output&nbsp;(MIMO) channels with joint sum and per-antenna power constraints. For the Gaussian MISO channels, a closed-form characterization of an optimal beamforming strategy is derived. It is shown that we can always find an optimal beamforming transmit strategy that allocates the maximal sum power with phases matched to the complex channel coefficients. An interesting property of the optimal power allocation is that whenever the optimal power allocation of the corresponding problem with sum power constraint only exceeds per-antenna power constraints, it is optimal to allocate maximal per-antenna power to those antennas to satisfy the per-antenna power constraints. The remaining power is distributed among the other antennas whose optimal allocation follows from a reduced joint sum and per-antenna power constraints problem with fewer channel coefficients and a reduced sum power constraint. For the Gaussian MIMO channels, it is shown that if an unconstraint optimal power allocation for an antenna exceeds a per-antenna power constraint, then the maximal power for this antenna is used in the constraint optimal transmit strategy. This observation is then used in an iterative algorithm to compute the optimal transmit strategy in closed-form.</p> \n<p>In the second part of the thesis, we investigate the optimal transmit strategies for Gaussian MISO wiretap channels. Motivated by the fact that the non-secure capacity of the MISO wiretap channels is usually larger than the secrecy capacity, we study the optimal trade-off between those two rates with different power constraint settings, in particular, sum power constraint only, per-antenna power constraints only, and joint sum and per-antenna power constraints. To characterize the boundary of the optimal rate region, which describes the optimal trade-off between non-secure transmission and secrecy rates, related problems to find optimal transmit strategies that maximize the weighted rate sum with different power constraints are derived. Since these problems are not necessarily convex, equivalent problem formulation is used to derive optimal transmit strategies. A closed-formsolution is provided for sum power constraint only problem. Under per-antenna power constraints, necessary conditions to find the optimal power allocation are provided. Sufficient conditions, however, are available for the case of two transmit antennas only. For the special case of parallel channels, the optimal transmit strategies can deduced from an equivalent point-to-point channel problem. In this case, there is no trade-off between secrecy and non-secrecy rate, i.e., there is onlya transmit strategy that maximizes both rates.</p> \n<p>Finally, the optimal transmit strategies for large-scale MISO and massive MIMO systems with sub-connected hybrid analog-digital beamforming architecture, RF chain and per-antenna power constraints are studied. The system is configured such that each RF chain serves a group of antennas. For the large-scale MISO system, necessary and sufficient conditions to design the optimal digital and analog precoders are provided. It is optimal that the phase at each antenna is matched tothe channel so that we have constructive alignment. Unfortunately, for the massive MIMO system, only necessary conditions are provided. The necessary conditions to design the digital precoder are established based on a generalized water-filling and joint sum and per-antenna optimal power allocation solution, while the analog precoder is based on a per-antenna power allocation solution only. Further, we provide the optimal power allocation for sub-connected setups based on two properties: (i) Each RF chain uses full power and (ii) if the optimal power allocation of the unconstraint problem violates a per-antenna power constraint then it is optimal to allocate the maximal power for that antenna. The results in the dissertation demonstrate that future wireless networks can achieved higher data rates with less power consumption. The designs of optimal transmit strategies provided in this dissertation are valuable for ongoing implementations in future wireless networks. The insights offered through the analysis and design of the optimal transmit strategies in the dissertation also provide the understanding of the optimal power allocation on practical multi-antenna systems.</p> \n",  "translations": [  "1.877427"  ],  "uriContentId": "1.877322",  "uri": "http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-247972"  },  {  "contentId": "1.877397",  "inputTemplate": "it.article.calendarevent",  "contentName": "Distributed Optimization in Time-Varying Environments",  "advisor": "Joakim Jaldén, Teknisk informationsvetenskap",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-08-19T08:00:00.000Z",  "defaultLocale": true,  "externalId": "diva2:1320235",  "lead": "",  "lecturer": "",  "locale": "en\_UK",  "location": "F3, Lindstedtsv ägen 26, Stockholm (English)",  "locationUrl": "https://www-r.referens.sys.kth.se/places/room/id/2b863516-4a75-4c89-94dd-03faf8e9258f",  "opponent": "Professor Alex Olshevsky, ",  "parentId": "2.86514",  "respondent": "Marie Maros",  "respondentUrl": "",  "respondentDepartment": "Teknisk informationsvetenskap, Information Science and Engineering",  "seminartype": "dissertation",  "subjectarea": "Electrical Engineering",  "paragraphs\_text": "<h2>Abstract</h2> \n<p>Solving optimization problems in a distributed manner is critical in many systems. Many relevant systems are distributed in nature in the sense that they consist of autonomous agents that are to come to a joint decision based on a certain metric. In many cases, these agents may collect information independently and would therefore have to centralize all the data. In applications were this is not a viable approach distributed solutions are desirable.</p> \n<p>In this thesis, we study distributed optimization methods in time-varying environments. In the first part of the thesis, we consider optimization problems that evolve over time in a controlled manner. We propose the use of the Alternating Direction Method of Multipliers (ADMM) due to its flexibility in step-size selection. We establish ADMM's ability to follow an optimal point as it moves over time. In our set-up, a distributed variant of ADMM is allowed to perform a single iteration per problem change. Under smoothness assumptions on the objective and constraint functions we establishthat there exists a sufficiently small variation of the problem data for which we can guarantee that ADMM will be able to follow the optimal point in a decentralized manner. These conditions are less stringent than the conditions found in the literature. Later on, we introduce a stochastic model for the variation of the problem's data. Under some assumptions, we establish that decentralized ADMM is capable of remaining in a bounded mean square neighbourhood of a primal-dual optimal point. Introducing a stochastic model allows to us relax many of the requirements found in the literature, while still providing some guarantees. We provide with application examples and simulations for both scenarios.</p> \n<p>In the second part of the thesis we consider distributed optimization methods that converge over time-varying networks. We propose the first dual method to converge linearly on time-varying networks, in which we allow the networks to become disconnected. We establish that the method converges R-linearly and illustrate that under some circumstances it performs better than other state of the art methods, while, at the same time, cutting the required information exchanges in half. Since the proposed method is computationally quite expensive we propose a linearized and therefore computationally cheaper version of our method. Finally, we establish that the linearized version will also converge R-linearly on time-varying graphs and quantify the loss in convergence rate due to the approximation.</p> \n",  "translations": [  "1.877415"  ],  "uriContentId": "1.877398",  "uri": "http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-252715"  },  {  "contentId": "1.877485",  "inputTemplate": "it.article.calendarevent",  "contentName": "Perspectives on Identification Systems",  "advisor": "Professor Tobias J. Oechtering, Teknisk informationsvetenskap; Professor Mikael Skoglund, Signaler, sensorer och system, Teknisk informationsvetenskap",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-08-29T13:15:00.000Z",  "defaultLocale": true,  "externalId": "diva2:1334211",  "lead": "",  "lecturer": "",  "locale": "en\_UK",  "location": "F3, Lindstedtsvägen 26, Stockholm (English)",  "locationUrl": "",  "opponent": "Professor Michael Gastpar, EPFL IC IINFCOM LINX, Lausanne, Switzerland",  "parentId": "2.86514",  "respondent": "Minh Thành Vu",  "respondentUrl": "",  "respondentDepartment": "Teknisk informationsvetenskap",  "seminartype": "dissertation",  "subjectarea": "Electrical Engineering",  "paragraphs\_text": "<h2>Abstract</h2> \n<p>Identification systems such as biometric identification systems have been becoming ubiquitous. Fundamental bounds on the performance of the systems have been established in literature. In this thesis we further relax several assumptions in the identification problem and derive the corresponding fundamental regions for these settings.</p> \n<p>The generic identification architecture is first extended so that users’ information is stored in two layers. Additionally, the processing is separated in two steps where the observation sequence in the first step is a noisy, pre-processed version of the original one. This setting generalizes several known settings in the literature. Given fixed pre-processing schemes, we study optimal trade-offs in the discrete and Gaussian cases. As corollaries we also provide characterizations for related problems.</p> \n<p>In a second aspect, the joint distribution in the identification problem is relaxed in several ways. We first assume that all users’ sequences are drawn from a common distribution, which depends on a state of the system. The observation sequence is induced by a channel which has its own state. Another variant, in which the channel is fixed, however the distributions of users’ sequences are not necessarily identical, is considered next. We then study the case that users’ data sequence are generated independently from a mixture distribution. Optimal performance regions of these settings are provided. We further give an inner bound and an outer bound on the region when the observation channel varies arbitrarily. Additionally, we strengthen the relation between the Wyner-Ahlswede-Körner problem and the identification problem and show the equivalence of these two.</p> \n<p>Finally, we study a binary hypothesis testing problem which decides whether or not the observation sequence is related to one user in the database. The optimal exponent of the second type of error is studied. Furthermore, we show that the single-user testing against independence problem studied by Ahlswede and Csiszár is equivalent to the identification problem as well as the Wyner-Ahlswede-Körner problem.</p> \n",  "translations": [  "1.877489"  ],  "uriContentId": "1.877486",  "uri": "http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-254611"  },  {  "contentId": "1.877528",  "inputTemplate": "it.article.calendarevent",  "contentName": "Inverse problems in signal processing",  "advisor": "Professor Joakim Jaldén, Teknisk informationsvetenskap",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-09-16T09:00:00.000Z",  "defaultLocale": true,  "externalId": "diva2:1343946",  "lead": "",  "lecturer": "",  "locale": "en\_UK",  "location": "F3, Lindstedtsvägen 26, Stockholm, Stockholm (English)",  "locationUrl": "",  "opponent": "Professor Yonina C. Eldar, Weizmann Institute of Science, Israel",  "parentId": "2.86514",  "respondent": "Pol del Aguila Pla",  "respondentUrl": "",  "respondentDepartment": "Teknisk informationsvetenskap",  "seminartype": "dissertation",  "subjectarea": "Electrical Engineering",  "paragraphs\_text": "<h2>Abstract</h2> \n<p>Inverse problems arise in any scientific endeavor. Indeed, it is seldom the case that our senses or basic instruments, i.e., the data, provide the answer we seek. It is only by using our understanding of how the world has generated the data, i.e., a model, that we can hope to infer what the data imply. Solving an inverse problem is, simply put, using a model to retrieve the information we seek from the data.</p> \n<p>In signal processing, systems are engineered to generate, process, or transmit signals, i.e., indexed data, in order to achieve some goal. The goal of a specific system could be to use an observed signal and its model to solve an inverse problem. However, the goal could also be to generate a signal so that it reveals a parameter to investigation by inverse problems. Inverse problems and signal processing overlap substantially, and rely on the same set of concepts and tools. This thesis lies at the intersection between them, and presents results in modeling, optimization, statistics, machine learning, biomedical imaging and automatic control.</p> \n<p>The novel scientific content of this thesis is contained in its seven composing publications, which are reproduced in Part II. In five of these, which are mostly motivated by a biomedical imaging application, a set of related optimization and machine learning approaches to source localization under diffusion and convolutional coding models are presented. These are included in Publications A, B, E, F and G, which also include contributions to the modeling and simulation of a specific family of image-based immunoassays. Publication C presents the analysis of a system for clock synchronization between two nodes connected by a channel, which is a problem of utmost relevance in automatic control. The system exploits a specific node design to generate a signal that enables the estimation of the synchronization parameters. In the analysis, substantial contributions to the identifiability of sawtooth signal models under different conditions are made. Finally, Publication D brings to light and proves results that have been largely overlooked by the signal processing community and characterize the information that quantized linear models contain about their location and scale parameters.</p> \n",  "translations": [  "1.877530"  ],  "uriContentId": "1.877529",  "uri": "http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-256079"  }  ]  **Response headers:**  content-length: 28100 content-type: application/json; charset=utf-8 date: Sat, 24 Aug 2019 10:39:19 GMT etag: W/"6dc4-WZV8zMe7AQOszzqm+VOLkqiq4Qs" x-powered-by: Express referrer-policy: origin-when-cross-origin strict-transport-security: max-age=31536000 |

The above returned a list of all of the dissertation calendar events for this department. If we just one a single calendar event we can do GET /v1/calendar/{contentId} as shown in Listing 1‑5

Listing ‑: Response to a query of the form https://api-r.referens.sys.kth.se/api/cortina/v1/calendar/1.870302

|  |
| --- |
| Code 200    **Response body:**  {  "contentId": "1.870302",  "inputTemplate": "it.article.calendarevent",  "contentName": "Characterisation, Modelling and Digital Pre-distortion Techniques for RF Transmitters in Wireless Systems ",  "advisor": "Professor Peter Händel",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-02-18T12:00:00.000Z",  "defaultLocale": true,  "externalId": "",  "lead": "",  "lecturer": "",  "locale": "sv\_SE",  "location": "Hörsal 99131; University of Gävle",  "locationUrl": "",  "opponent": "Professor Noureddine Boulejfen, Research Center for Microelectronics and Nanotechnology, Technopole de Sousse, Sousse, Tunisia ",  "parentId": "2.86514",  "respondent": "Mahmoud Alizadeh",  "respondentUrl": "",  "respondentDepartment": "Teknisk informationsvetenskap",  "seminartype": "dissertation",  "subjectarea": "Elektro- och systemteknik",  "paragraphs\_text": "",  "translations": [  "1.870304"  ],  "uriContentId": "",  "uri": ""  }  **Response headers:**  content-length: 874 content-type: application/json; charset=utf-8 date: Sat, 24 Aug 2019 12:02:47 GMT etag: W/"36a-bY+8Km2h1qz4V5e29fdyfS0KBP0" x-powered-by: Express referrer-policy: origin-when-cross-origin strict-transport-security: max-age=31536000 |

Another call for licentiates in EECS/COS is   
<https://api-r.referens.sys.kth.se/api/cortina/v1/calendarlist/2.86618> the output is shown in Listing 1‑6.

Listing ‑: EECS/COS licentate calendar list

|  |
| --- |
| [  {  "contentId": "1.876871",  "inputTemplate": "it.article.calendarevent",  "contentName": "Realizing Low-Latency Internet Services via Low-Level Optimization of NFV Service Chains",  "advisor": "Dejan Kostic, ; Gerald Q. Maguire Jr., ",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-06-13T07:30:00.000Z",  "defaultLocale": true,  "externalId": "diva2:1305108",  "lead": "",  "lecturer": "",  "locale": "en\_UK",  "location": "Sal B, Electrum, KTH, Kistagången 16, Kista (English)",  "locationUrl": "https://www-r.referens.sys.kth.se/places/room/id/7f6bc835-a9bc-4b9b-983a-376742c11cdd",  "opponent": "Professor Babak Falsafi, EPFL – École polytechnique fédérale de Lausanne",  "parentId": "2.86618",  "respondent": "Alireza Farshin",  "respondentUrl": "https://www.kth.se/profile/farshin",  "respondentDepartment": "Network Systems Laboratory (NS Lab)",  "seminartype": "licentiate",  "subjectarea": "Information and Communication Technology",  "paragraphs\_text": "<h2>Abstract</h2> \n<p>By virtue of the recent technological developments in cloud computing, more applications are deployed in a cloud. Among these modern cloud-based applications, some require bounded and predictable low-latency responses. However, the current cloud infrastructure is unsuitable as it cannot satisfy these requirements, due to many limitations in both hardware and software.</p> \n<p>This licentiate thesis describes attempts to reduce the latency of Internet services by carefully studying the currently available infrastructure, optimizing it, and improving its performance. The focus is to optimize the performance of network functions deployed on commodity hardware, known as network function virtualization (NFV). The performance of NFV is one of the major sources of latency for Internet services.</p> \n<p>The first contribution is related to optimizing the software. This project began by investigating the possibility of superoptimizing virtualized network functions(VNFs). This began with a literature review of available superoptimization techniques, then one of the state-of-the-art superoptimization tools was selected to analyze the crucial metrics affecting application performance. The result of our analysis demonstrated that having better cache metrics could potentially improve the performance of all applications.</p> \n<p>The second contribution of this thesis employs the results of the first part by taking a step toward optimizing cache performance of time-critical NFV service chains. By doing so, we reduced the tail latencies of such systems running at 100Gbps. This is an important achievement as it increases the probability of realizing bounded and predictable latency for Internet services.</p> \n",  "translations": [  "1.876885"  ],  "uriContentId": "1.877337",  "uri": "http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-249664"  },  {  "contentId": "1.877407",  "inputTemplate": "it.article.calendarevent",  "contentName": "Toward Next-generation Data Centers",  "advisor": "Dejan Kostic, ; Gerald Q. Maguire Jr., ; Dr. Fetahi Wuhib, Ericsson Research",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-05-10T07:30:00.000Z",  "defaultLocale": true,  "externalId": "diva2:1304795",  "lead": "",  "lecturer": "",  "locale": "en\_UK",  "location": "Sal B, Electrum, KTH, Kistagången 16, Kista., Stockholm (English)",  "locationUrl": "https://www-r.referens.sys.kth.se/places/room/id/7f6bc835-a9bc-4b9b-983a-376742c11cdd",  "opponent": "Reader (Associate Professor) Boris Grot, School of Informatics University of Edinburgh",  "parentId": "2.86618",  "respondent": "Amir Roozbeh",  "respondentUrl": "https://www.kth.se/profile/amirrsk",  "respondentDepartment": "Kommunikationssystem, CoS, Ericsson Research",  "seminartype": "licentiate",  "subjectarea": "Information and Communication Technology",  "paragraphs\_text": "<h2>Abstract</h2> \n<p>The cloud is evolving due to additional demands introduced by new technological advancements and the wide movement toward digitalization. Therefore, next-generation data centers (DCs) and clouds are expected (and need) to become cheaper, more efficient, and capable of offering more predictable services.</p> \n<p>Aligned with this, we examine the concept of software-defined “hardware” infrastructures (SDHI) based on hardware resource disaggregation as one possible way of realizing next-generation DCs. We start with an overview of the functional architecture of a cloud based on SDHI. Following this, we discuss a series of use-cases and deployment scenarios enabled by SDHI and explore the role of each functional block of SDHI’s architecture, i.e., cloud infrastructure, cloud platforms, cloud execution environments, and applications.</p> \n<p>Next, we propose a framework to evaluate the impact of SDHI on techno-economic efficiency of DCs, specifically focusing on application profiling, hardware dimensioning, and total cost of ownership (TCO). Our study shows that combining resource disaggregation and software-defined capabilities makes DCs less expensive and easier to expand; hence they can rapidly follow the exponential demand growth. Additionally, we elaborate on technologies behind SDHI, its challenges, and its potential future directions.</p> \n<p>Finally, to identify a suitable memory management scheme for SDHI and show its advantages, we focus on the management of Last Level Cache (LLC) in currently available Intel processors. Aligned with this, we investigate how better management of LLC can provide higher performance, more predictable response time, and improved isolation between threads. More specifically, we take advantage of LLC’s non-uniform cache architecture (NUCA) in which the LLC is divided into “slices,” where access by the core to which it closer is faster than access to other slices. Based upon this, we introduce a new memory management scheme, called slice-aware memory management, which carefully maps the allocated memory to LLC slices based on their access time latency rather than the de facto scheme that maps them uniformly. Many applications can benefit from our memory management scheme with relatively small changes. As an example, we show the potential benefits that Key-Value Store (KVS) applications gain by utilizing our memory management scheme. Moreover, we discuss how this scheme could be used to provide explicit CPU slicing – which is one of the expectations of SDHI &nbsp;and hardware resource disaggregation.</p> \n",  "translations": [  "1.877467"  ],  "uriContentId": "1.877408",  "uri": "http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-249618"  }  ] |

One can get the individual events (such as 1.876871) <https://api-r.referens.sys.kth.se/api/cortina/v1/calendar/1.876871> as shown in

Listing ‑: A licentiate presentation

|  |
| --- |
| **Response body:**  {  "contentId": "1.876871",  "inputTemplate": "it.article.calendarevent",  "contentName": "Realizing Low-Latency Internet Services via Low-Level Optimization of NFV Service Chains",  "advisor": "Dejan Kostic, ; Gerald Q. Maguire Jr., ",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-06-13T07:30:00.000Z",  "defaultLocale": true,  "externalId": "diva2:1305108",  "lead": "",  "lecturer": "",  "locale": "en\_UK",  "location": "Sal B, Electrum, KTH, Kistagången 16, Kista (English)",  "locationUrl": "https://www-r.referens.sys.kth.se/places/room/id/7f6bc835-a9bc-4b9b-983a-376742c11cdd",  "opponent": "Professor Babak Falsafi, EPFL – École polytechnique fédérale de Lausanne",  "parentId": "2.86618",  "respondent": "Alireza Farshin",  "respondentUrl": "https://www.kth.se/profile/farshin",  "respondentDepartment": "Network Systems Laboratory (NS Lab)",  "seminartype": "licentiate",  "subjectarea": "Information and Communication Technology",  "paragraphs\_text": "<h2>Abstract</h2> \n<p>By virtue of the recent technological developments in cloud computing, more applications are deployed in a cloud. Among these modern cloud-based applications, some require bounded and predictable low-latency responses. However, the current cloud infrastructure is unsuitable as it cannot satisfy these requirements, due to many limitations in both hardware and software.</p> \n<p>This licentiate thesis describes attempts to reduce the latency of Internet services by carefully studying the currently available infrastructure, optimizing it, and improving its performance. The focus is to optimize the performance of network functions deployed on commodity hardware, known as network function virtualization (NFV). The performance of NFV is one of the major sources of latency for Internet services.</p> \n<p>The first contribution is related to optimizing the software. This project began by investigating the possibility of superoptimizing virtualized network functions(VNFs). This began with a literature review of available superoptimization techniques, then one of the state-of-the-art superoptimization tools was selected to analyze the crucial metrics affecting application performance. The result of our analysis demonstrated that having better cache metrics could potentially improve the performance of all applications.</p> \n<p>The second contribution of this thesis employs the results of the first part by taking a step toward optimizing cache performance of time-critical NFV service chains. By doing so, we reduced the tail latencies of such systems running at 100Gbps. This is an important achievement as it increases the probability of realizing bounded and predictable latency for Internet services.</p> \n",  "translations": [  "1.876885"  ],  "uriContentId": "1.877337",  "uri": "http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-249664"  } |

To get the translation one has to do another GET, specifically <https://api-r.referens.sys.kth.se/api/cortina/v1/calendar/1.876885> - the results are shown in Listing 1‑8.

Listing ‑: Translation

|  |
| --- |
| {  "contentId": "1.876885",  "inputTemplate": "it.article.calendarevent",  "contentName": "Realizing Low-Latency Internet Services via Low-Level Optimization of NFV Service Chains",  "advisor": "Dejan Kostic, ; Gerald Q. Maguire Jr., ",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-06-13T07:30:00.000Z",  "defaultLocale": false,  "externalId": "",  "lead": "",  "lecturer": "",  "locale": "sv\_SE",  "location": "Sal B, Electrum, KTH, Kistagången 16, Kista (Engelska)",  "locationUrl": "https://www-r.referens.sys.kth.se/places/room/id/7f6bc835-a9bc-4b9b-983a-376742c11cdd",  "opponent": "Professor Babak Falsafi, EPFL – École polytechnique fédérale de Lausanne",  "parentId": "1.876871",  "respondent": "Alireza Farshin",  "respondentUrl": "https://www.kth.se/profile/farshin",  "respondentDepartment": "Network Systems Laboratory (NS Lab)",  "seminartype": "licentiate",  "subjectarea": "Informations- och kommunikationsteknik",  "paragraphs\_text": "<h2>Abstract</h2> \n<p>Tack vare den senaste tekniska utvecklingen inom beräkningar i molnet(“cloud computing”) används allt fler tillämpningar i molnlösningar. Flera avdessa moderna molnbaserade tillämpningar kräver korta svarstider är låga ochatt dessa ska vara förutsägbara och ligga inom givna gränser. Den nuvarandemolninfrastrukturen är dock otillräcklig eftersom den inte kan uppfylla dessa krav,på grund av olika typer av begränsningar i både hårdvara och mjukvara.</p> \n<p>I denna licentiatavhandling beskrivs försök att minska fördröjningen iinternettjänster genom att noggrant studera den nuvarande tillgängligainfrastrukturen, optimera den och förbättra dess prestanda. Fokus ligger påatt optimera prestanda för nätverksfunktioner som realiseras med hjälp avstandardhårdvara, känt som nätverksfunktionsvirtualisering (NFV). Prestanda hosNFV är en av de viktigaste källorna till fördröjning i internettjänster.</p> \n<p>Det första bidraget är relaterat till att optimera mjukvaran. Detta projektbörjade med att undersöka möjligheten att “superoptimera” virtualiseradenätverksfunktioner (VNF). Detta inleddes med en litteraturöversikt av tillgängligasuperoptimeringstekniker, och sedan valdes ett av de toppmodernasuperoptimeringsverktygen för att analysera de viktiga mätvärden som påverkartillämpningssprestanda. Resultatet av vår analys visade att bättre cache-mätningar potentiellt skulle kunna förbättra prestanda för alla tillämpningar.</p> \n<p>Det andra bidraget i denna avhandling utnyttjar resultaten från den förstadelen genom att ta ett steg mot att optimera cache-prestanda för tidskritiskakedjor av NFV-tjänster. Genom att göra så reducerade vi de långa fördröjningarnahos sådana system som kördes vid 100 Gbps. Detta är en viktig bedrift eftersomdetta ökar sannolikheten för att uppnå en begränsad och förutsägbar fördrörninghos internettjänster.</p> \n",  "translations": [],  "uriContentId": "1.877337",  "uri": "http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-249664"  } |

It is also possible to update a calendar event with PUT and to create a calendar event with POST.

# Understanding the model and how it might be used for a thesis presentation

The model for a calendar event is shown in Listing 2‑1. From Listing 1‑7 and Listing 1‑8 we can see that the language for a give calendar event is described by the “locale” field. For example, English is indicated as "locale": "en\_UK", while Swedish is indicated by "locale": "sv\_SE". Note that the language of the presentation is given at the end of the location, as "location": "Sal B, Electrum, KTH, Kistagången 16, Kista (English)", and "location": "Sal B, Electrum, KTH, Kistagången 16, Kista (Engelska)" in the English and Swedish versions of the announcement. Note also the use of the "locationUrl": <https://www-r.referens.sys.kth.se/places/room/id/7f6bc835-a9bc-4b9b-983a-376742c11cdd>.

Listing ‑: Model for a calendar event

|  |
| --- |
| CalendarEvent{  contentId string Unique identifier, same as polopoly content id  representing some CalendarEvent data  contentName string  advisor string Name of advisor / supervisor / ths  dates\_allday boolean  dates\_endtime string  dates\_starttime string  defaultLocale boolean  lead string  locale {...}  location string  opponent string  paragraphs\_text string  respondent string  respondentDepartment string  seminartype string Enum: [dissertation, licentiate, thesis]  subjectarea string  } |
|  |

Note that for the date, the information is given in UTC time as "dates\_starttime": "2019-06-13T07:30:00.000Z". Generally one will also specify "dates\_allday": false, "dates\_endtime": "none", as the presentation only lasts for a “short” time and not all day and there is not fixed stopping time.

For a thesis presentation one will use the fields: "lead" and "lecturer"; but not use the fields:”Respondent” or “respondentDepartment”. The values for the leads are shown in Table 2‑1.

Table ‑: Lead values

|  |  |  |
| --- | --- | --- |
| 2nd cycle | Lead | Master's thesis presentation |
| Swedish lead | Examensarbete presentation |
| 1st cycle | Lead | Bachelor's thesis presentation |
| Swedish lead | Kandidate Examensarbete presentation |

The field "contentName" will contain the title in the language of the calendar event. The field "advisor" will contain the examiner and supervisor(s) name. The field "opponent" will contain the opponents names, semicolon separated.

Inserting a calendar event can be done using:

curl -X POST "https://api-r.referens.sys.kth.se/api/cortina/v1/calendar/" -H "accept: application/json" -H "api\_key: xxxxxxx" -H "Content-Type: application/json" -d "{ \"contentId\": \"\", \"contentName\": \"A very impressive title: Make it simple\", \"advisor\": \"Professor Gerald Q. Maguire Jr.; A. B. Normal\", \"dates\_allday\": false, \"dates\_endtime\": \"\", \"dates\_starttime\": \"2019-08-24T14:00:00.000Z\", \"defaultLocale\": true, \"lead\": \"Master's thesis presentation\", \"location\": \"Seminar room Grimeton at COM (Kistagången 16), East, Floor 4, Kista (English)\", \"opponent\": \"A. N. Opponent\", \"paragraphs\_text\": \"string\", \"respondent\": \"A. N. Fakestudent\", \"respondentDepartment\": \"Network Systems Laboratory (NS Lab)\", \"seminartype\": \"thesis\", \"subjectarea\": \"Information and Communication Technology\"}"

This returned the response shown in

|  |
| --- |
| **Code** 200  **Response body:**  {  "contentId": "99.03624",  "contentName": "A very impressive title: Make it simple",  "inputTemplate": "it.article.calendarevent",  "advisor": "Professor Gerald Q. Maguire Jr.; A. B. Normal",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-08-24T14:00:00.000Z",  "defaultLocale": true,  "externalId": "",  "lead": "Master's thesis presentation",  "lecturer": "",  "locale": "sv\_SE",  "location": "Seminar room Grimeton at COM (Kistagången 16), East, Floor 4, Kista (English)",  "locationUrl": "",  "opponent": "A. N. Opponent",  "respondent": "A. N. Fakestudent",  "respondentUrl": "",  "respondentDepartment": "Network Systems Laboratory (NS Lab)",  "seminartype": "thesis",  "subjectarea": "Information and Communication Technology",  "paragraphs\_text": "",  "parentId": "",  "translations": [],  "uriContentId": "",  "uri": ""  }  **Response headers:**  content-length: 787  content-type: application/json; charset=utf-8 date: Sat, 24 Aug 2019 14:24:53 GMT  etag: W/"313-abch2l7XDhaV3Liyb8dhUJXCeEU"  x-powered-by: Express  referrer-policy: origin-when-cross-origin  strict-transport-security: max-age=31536000 |

The above tells us that "defaultLocale": true, leads to a “locale” of “sv\_SE”.en\_ One can change the language with a PUT via the request shown in Listing 2‑2, i.e., the body shown in Listing 2‑3. Finally the response is shown in xxx.

Listing ‑: Put request to update a calendar entry

|  |
| --- |
| curl -X PUT "https://api-r.referens.sys.kth.se/api/cortina/v1/calendar/99.03624" -H "accept: application/json" -H "api\_key: xxxxxxx" -H "Content-Type: application/json" -d "{ \"contentId\": \"99.03624\", \"contentName\": \"A very impressive title: Make it simple\", \"advisor\": \"Professor Gerald Q. Maguire Jr.; A. B. Normal\", \"dates\_allday\": false, \"dates\_endtime\": \"\", \"dates\_starttime\": \"2019-08-24T14:00:00.000Z\", \"locale\": \"en\_UK\", \"lead\": \"Master's thesis presentation\", \"location\": \"Seminar room Grimeton at COM (Kistagången 16), East, Floor 4, Kista (English)\", \"opponent\": \"A. N. Opponent\", \"paragraphs\_text\": \"string\", \"lecturer\": \"A. N. Fakestudent\", \"respondentDepartment\": \"Network Systems Laboratory (NS Lab)\", \"seminartype\": \"thesis\", \"subjectarea\": \"Information and Communication Technology\"}" |

Listing ‑: Body for PUT

|  |
| --- |
| {  "contentId": "99.03624",  "contentName": "A very impressive title: Make it simple",  "advisor": "Professor Gerald Q. Maguire Jr.; A. B. Normal",  "dates\_allday": false,  "dates\_endtime": "",  "dates\_starttime": "2019-08-24T14:00:00.000Z",  "locale": "en\_UK",  "lead": "Master's thesis presentation",  "location": "Seminar room Grimeton at COM (Kistagången 16), East, Floor 4, Kista (English)",  "opponent": "A. N. Opponent",  "paragraphs\_text": "string",  "lecturer": "A. N. Fakestudent",  "respondentDepartment": "Network Systems Laboratory (NS Lab)",  "seminartype": "thesis",  "subjectarea": "Information and Communication Technology"  } |

|  |
| --- |
| **Code** 200  **Response body:**  {  "contentId": "99.03624",  "contentName": "A very impressive title: Make it simple",  "advisor": "Professor Gerald Q. Maguire Jr.; A. B. Normal",  "dates\_allday": false,  "dates\_endtime": "none",  "dates\_starttime": "2019-08-24T14:00:00.000Z",  "defaultLocale": true,  "externalId": "",  "lead": "Master's thesis presentation",  "lecturer": "A. N. Fakestudent",  "locale": "en\_UK",  "location": "Seminar room Grimeton at COM (Kistagången 16), East, Floor 4, Kista (English)",  "locationUrl": "",  "opponent": "A. N. Opponent",  "respondent": "",  "respondentUrl": "",  "respondentDepartment": "Network Systems Laboratory (NS Lab)",  "seminartype": "thesis",  "subjectarea": "Information and Communication Technology",  "paragraphs\_text": "",  "translations": [],  "uriContentId": "",  "uri": ""  }  **Response headers:**  content-length: 730  content-type: application/json; charset=utf-8 date: Sat, 24 Aug 2019 14:34:44 GMT  etag: W/"2da-LtyC+A6UZYbpw/2xpPWPnXlrGiU"  x-powered-by: Express  referrer-policy: origin-when-cross-origin  strict-transport-security: max-age=31536000 |

However, trying to get the resulting calendar, with the request shown in Listing 2‑4

Yields the result shown in xxx

Listing ‑: Request to get the new calendar item

|  |
| --- |
| curl -X GET "https://api-r.referens.sys.kth.se/api/cortina/v1/calendar/99.03624" -H "accept: application/json" -H "api\_key: xxxxxxx" |

Listing ‑: Response to the request

|  |
| --- |
| **Code** 404 Error: Not Found  **Response body:**  {  "message": "Not Found: /api/cortina/v1/calendar/99.03624"  }  **Response headers:**  content-length: 58  content-type: application/json; charset=utf-8 date: Sat, 24 Aug 2019 14:40:26 GMT  etag: W/"3a-e1vB5R8rPXOdaYYFAd1uvDcJHEw"  x-powered-by: Express  referrer-policy: origin-when-cross-origin  strict-transport-security: max-age=31536000 |